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ORO-R-2 (FEC)

TACTICAL EMPLOYMENT OF ATOMIC WEAPONS

by

L. H. RUMBAUGH
J. B. GREEN
S. H. TURKEL
H. W. BRACKNEY

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Per Eugene J. Auto, Asst Sec Off, O.R.O.
(Name) (Grade) (Organization)

1 MARCH 1951

SECRET

OFFICE, CHIEF OF ARMY FIELD FORCES
Fort Monroe, Virginia S: 29 September 1951

ATTNG-80/96-2 000.9/25(C)(7 Sep 51) 7 September 1951

SUBJECT: ORO-R-2(FEC), "Tactical Employment of Atomic Weapons"

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TO: See Distribution

1. Reference is made to inclosure to letter, OCAFF, ATTNG-80/39-6 000.9/8(C)(25 Apr 51), 25 April 1951, subject: "Responsibilities in Connection with the Employment of Atomic Missiles."

2. Inclosed is a copy of ORO-R-2(FEC) "Tactical Employment of Atomic Weapons," for review and consideration by your headquarters.

3. This study currently is being reviewed in this Office and Department of the Army. Consequently it is not possible at this time to formulate an Army position with regard to the conclusions and recommendations of the study. However, it is felt that substantial benefits will accrue to the Army from the formulation of a course of action based in part on the conclusions and recommendations of the study following the application of considered military judgment to the various operational aspects of the problem.

4. Accordingly, it is requested that your comments and recommendations with regard to this study be submitted in duplicate to this Office, Attention: ATTNG-80, on or before 29 September 1951.

5. Copies of study may be withdrawn for your files.

FOR THE CHIEF OF ARMY FIELD FORCES:

W H Melhorn
W. H. MELHORN
Lt Col, AGC
Asst Adjutant General

1 Incl
ORO-R-2(FEC) "Tactical Employment of Atomic Weapons"

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GENERAL HEADQUARTERS
FAR EAST COMMAND
APO 500

AG 471.6 (1 Mar 51)GC-O UNCLASSIFIED 20 July 1951

SUBJECT: Tactical Employment of Atomic Weapons (ORO-R-2 (FEC))

TO: The Chief of Staff
United States Army
Washington 25, D.C.

1. Attached is the final report on above subject, recently completed by Director, Operations Research Office (ORO), Far East Command. Four (4) advance copies of the report were forwarded to Department of the Army without comment on 5 June 1951. Six hundred and fifty (650) copies have been furnished the Director of Operations Research Office for delivery to Assistant Chief of Staff, G-4, Department of the Army. Two hundred and thirty-five (235) additional copies have been forwarded to Operations Research Office, Department of the Army. No other distribution has been made outside the Far East Command, nor is any contemplated.

2. This report is a comprehensive analysis of the technical and tactical considerations incident to employment of atomic weapons in support of ground troops. Although the study is pointed toward possible employment of atomic weapons in Korea, all phases of the report should be of great value to commanders from theater through corps anywhere.

3. Illustrations indicate the probable casualties and damage in several instances where the atomic bomb might have been employed with decisive results by either side. The report offers constructive suggestions for pointing intelligence procedures and means toward timely disclosure of targets suitable for atomic attack, and points out the need for the inclusion on staffs (theater through corps) of officers qualified in the capabilities and effects of atomic weapons. The report also points out that additional training as well as detection devices and medical supplies are needed prior to use of the atomic bomb in this Theater.

4. Appropriate parts of the report, such as the portions pertaining to the use of cover, troop deployment, and selection of terrain, should be extracted and included in the training and schooling of all non-commissioned and commissioned officers.

5. This headquarters is continuing study of subject report with a view to taking any actions that may be indicated to prepare the Far East Command offensively and defensively for possible employment of atomic weapons.

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AG 471.6 (1 Mar 51) GC-O, subj: Tactical Employment of Atomic Weapons (ORO-R-2 (FEC)), 20 Jul 51

6. Specific comments on the conclusions and recommendations of the report are presented in Inclosure 2.

FOR THE COMMANDER-IN-CHIEF:

DOYLE O. HICKEY
Lieutenant General, General Staff Corps
Chief of Staff

2 Incls
1. ORO-R-2 (FEC), 1 Mar 51
2. Specific GHQ Comments

Incl. 2 to Ltr, GHQ, FEC, AG 471.6 (1 Mar 51)GC-O, subj: Tactical Employment of Atomic Weapons (ORO-R-2 (FEC)), 20 Jul 51

SPECIFIC COMMENTS

Following are specific comments by the Commander-in-Chief, Far East, on the conclusions and recommendations as given in paragraphs 25 to 43 inclusive of subject report:

1. Para 25. No comment.

2. Para 26. An equally effective time for UN forces to employ atomic warheads would be when CCF troops are detected in assembly areas beyond artillery range. Atomic attacks on such assembly areas would have the advantage of striking maximum sized enemy concentrations, being far enough in front of friendly positions as not to endanger them and having maximum psychological effect on friendly and enemy troops.

3. Para 27. No comment.

4. Para 28. In regard to indicated vulnerability of UN targets, it should be remembered that there is no indication of early employment of atomic weapons by the enemy.

5. Para 29. Concur.

6. Para 30. Present intelligence procedures have successfully established the existence of large targets of opportunity during operations in Korea, such as reserve troop concentrations of division strength. Attack of such targets by atomic bombs would have been precluded in most cases, however, by the time required from first target identification until the actual drop of the bomb over the target.

7. Para 31. 1:2000 reconnaissance photos of Korean terrain would be of value in the location of enemy troop concentrations up to a certain point. Chinese troops have displayed great skill in constructing well concealed shelters with overhead cover, planted with local vegetation, and have demonstrated the requisite discipline in inhibiting all movement from the shelters in daylight. The initiation of atomic warfare will accelerate the development of these qualities in the enemy troops. The value of daylight photography suffers accordingly, since even if the shelters are detected, there is no means of knowing that troops are occupying them. It is believed that greater use of night photography would give more reliable results. The use of the polaroid camera with greatly increased speed in reporting might prove to be the solution since a flash interpretation would give coordinates of the target and an atomic attack might be launched before any substantial displacement of the enemy troops.

8. Para 32. Concur. In this connection, if atomic weapons had been available at airfields in close proximity to the front for delivery by medium bombers or if weapons suitable for delivery by fighters and/or artillery had been available, many large concentrations of Chinese troops might have been decisively attacked therewith.

9. Para 33. Do not concur. The value of such a weapon in delivering fire on targets of opportunity would justify engineer effort that might be required.

10. Para 34. Comment: The MPQ-2 radar adaptation of the SCR 584 AA Radar has proven accurate in placing bombs on the target and is being used successfully in close support of the infantry short of the bombline, and for night bombing beyond and within artillery range, with complete safety to friendly troops.

11. Para 35. The operations and intelligence staffs were not conducting atomic type warfare in the historical examples considered in the text. If the decision were made to utilize atomic weapons in this theater, it is believed that the inclusion of appropriately trained personnel in existing staffs combined with appropriate emphasis on location of area targets suitable for atomic attack would fulfill the requirements for effective utilization of this weapon.

12. Para 36. It would appear that 10 atomic warheads per opposing enemy division is excessive. Further, it appears that such a plan violates a basic principle of Economy of Force. The effectiveness of an atomic attack will depend somewhat on the element of surprise. Once that has been dissipated it is logical to assume that the enemy will make every effort to avoid concentrations in sufficient numbers to make the employment of this weapon profitable.

13. Para 37. Phases I, II and III of the Army atomic energy indoctrination program have been or will be completed within a short period of time for all units in this command except those in Korea. Phases II and III indoctrination of personnel in the zone of the interior before shipment to FEC is desirable and would alleviate this training deficiency in Eighth Army. In accordance with DA letter AGAO-S 353 (2 Jan 51) G3-M, subject: Integration of Chemical, Biological and Radiological Defense Training, 25 January 51, the training and subsequent integration into FEC Army units, of chemical defense officers and non-commissioned officers (radiological defense included) began on 2 July 1951. It is estimated that this program will provide between 65% and 75% of the required chemical defense personnel by July 1952.

14. Para 38. Concur that this should be done at the appropriate time. In addition to medical supply problems, the possible employment of atomic weapons raises many other logistical problems.

15. Para 39. Concur.

16. Para 40-43 inclusive. Do not concur. Present staff organization and procedures can be adapted to the effective tactical employment of atomic weapons by the inclusion on existing staffs of officers qualified in the capabilities and limitations of atomic weapons. Reference paragraph 41, ORO has published a Technical Memorandum ORO-T-13 (EUSAK), subject: A

Proposed Joint Intelligence Center for the Selection of Targets in Air Support and Ground Action, dated 28 February 1951. GHQ evaluation of this Technical Memorandum has been forwarded to Department of the Army by GHQ FEC letter, AG 300.2 (8 July 51)GC-O, subj: Operations Research Memorandum, 8 July 51. This letter recommended that no action be taken at this time to change the present Joint Operations Center system for the coordination of Air-Ground Operations.

15669—FEC P&PC—7/51—1M

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ORO-R-2 (FEC)
1 March 1951

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L. H. Rumbaugh
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Operations Research Office
The Johns Hopkins University
Far East Command

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The conclusions and recommendations of this Report are those of the Operations Research Office. No official approval of the Department of the Army, express or implied, should be inferred.

A large number of copies of this report is available for school purposes after comments from offices receiving the original distribution have been noted by G-3. These additional copies will be furnished by ORO on request through authorized Army channels.

ACKNOWLEDGEMENTS

The present studies of the tactical employment of atomic weapons are based in considerable measure on situations in the Korean Campaign. These studies have been made possible through the cooperation and support of many units and individuals in the Far East Command. This whole-hearted cooperation is best evidenced by the fact that the list of individuals who have contributed information and support is too long to cite here.

The authors gratefully acknowledge the aid of many officers and civilion staff members of General Headquarters, and Far East Air Force in Japan, and of the officers and men of the Eigth US Army and the Fifth Air Force in Korea.

The authors have drawn freely upon experience and information made available to them by the 2d Logistical Command, and by the G-2, G-3, G-4, and Armor Sections of EUSAK; by Joint Operations Center, TAEGU; by the 363 Photo Reconnaissance Technical Squadron; by G-3 Section, IX Corps; by the Chief of Staff and his aide, and by G-2 and G-3 Sections, I Corps; by 2143rd Air Weather Wing, FEAF; by G-2, G-3, Chemical, and Medical Sections, GHQ, FEC; by the Atomic Bomb Casualty Commission; and by the Scientific and Technical Section, ESS, FEC.

Some important parts of the present report are the work of others, who are credited by footnotes or signatures in various Appendices, Annexes and Inclosures. These contributors include particularly D. J. Belcher, W. L. Whitson, G. S. Pettee, Lloyd D. Yates, G. Donovan, R. F. Voigt, Lt Col Chas. Billingslea, and Maj D. H. Behrens.

The members of the atomic weapons project team of ORO are especially appreciative of the personal interest and round-the-clock support of Col N. I. Fooks, Chief, Operations Division, G-3, GHQ and of Col W. C. Bullock, Executive Officer, G-3 Section, EUSAK.

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SUMMARY

This dooument contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

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SUMMARY

PROBLEM

1. To study the employment of atomic weapons in tactical support of ground forces in the field, using Korea and the Korean campaign as laboratory and laboratory material to add realism to studies that have hitherto been entirely hypothetical.

FACTS

2. Reasonably precise factual data, based on information already issued by the Atomic Energy Commission, can serve as a basis for estimating casualties to personnel and materiel. Unless otherwise indicated, the data and estimates presented herein are based on effects of an atomic weapon equivalent to 40 kilotons of TNT.

3. No assumptions are made with respect to any high-level plans or decisions already made, or which may be made in the future, about allocation of atomic weapons to tactical employment.

4. Radiological-warfare considerations are beyond the scope of this report except insofar as radiological effects may result from explosion of an atomic warhead.

DISCUSSION

Atomic Weapons Effects (Appendix A)

5. Methods are evolved for estimating the physical effects of atomic weapons on ground-force targets under various external conditions of meteorology, terrain and cover. It is shown that in general, troop targets can be divided arbitrarily into three classes of vulnerability. Rules, graphs, and tables are given for estimating casualties in each vulnerability class from 40-KT air bursts. Scaling laws also are given for predicting the effects of atomic weapons of other KT equivalents.

6. For complex targets, consisting of both hard and

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soft components, it is shown that it is possible to choose a height of burst that will maximize the area over which any given type and degree of damage (blast, thermal, or penetrating radiation) will be spread. It usually is possible to arrive at a compromise burst height that will achieve the desired results on all classes of components.

7. Haze and fog tend to diminish the range of physical effects, particularly thermal radiation. Roughness of terrain tends to alter the pattern of blast effects. Some examples of Korean terrain and meteorology serve as illustrations to show that, in Korea, these would not play a major role in changing the effects of atomic explosions.

Analysis of Targets and Tactics (Appendix B)

8. Twenty-two types of tactical targets that can be attacked effectively with atomic warheads are listed roughly in order of profitableness, the more lucrative targets at the beginning, generally "soft" targets, for attack by high air bursts, and the less lucrative targets near the end, generally "hard" targets requiring low air bursts or surface or underground bursts.

9. Rough estimates of expected casualties in several types of tactical situations are made. Tables are included for determining safety of friendly troops in the case of atomic attack in close support of UN forces. The results are applied to the problem of perimeter defense.

10. Atomic weapons used in close support require target marking and local ground-control systems of more exacting specifications than normally used. Several systems are discussed.

11. In a coordinated atomic attack on several points in a large area, safety of delivery planes requires careful consideration of burst heights and aiming points. Separations of aiming points and times between missions must also be planned to avoid atomic explosions of low order resulting from stray neutrons left over from prior explosions in the neighborhood.

12. Defensive tactics, offensive tactics, disengagement and withdrawal, neutralization of large areas, interdiction of supply routes, guerrilla warfare, and sabotage are discussed.

Intelligence Requirements (Appendix C)

13. Requirements to insure the effectiveness of atomic

weapons impose heavy demands on intelligence, for inaccuracies or delays in intelligence reduce the effectiveness of the weapons as much as do errors of delivery.

14. Two assumed situations are given as illustrations to demonstrate the importance of intelligence accuracy by contrasting the effects resulting from good intelligence information with those resulting from poor intelligence information.

15. Four annexes to Appendix C discuss several aspects of the intelligence problem: (a) Annex 1 shows how a study of spot reports at corps, when integrated with army-level intelligence, could have predicted the attack by CCF and NKA against Line Baker on the night of 31 December-1 January. The use of 6 atomic weapons against concentrations totaling 120,000 CCF and NKA troops would have resulted in 30,000 or more casualties. (b) An entire Chinese army, the 66th, was in the vicinity of Taechon on 25 November 1950. Annex 2 shows that if intelligence and operational procedures were improved, amplified, and speeded up, this force could have been destroyed as a coordinated, functioning army by a single atomic air burst during the night of 25-26 November. (c) Annex 3 presents a summary of possible personnel targets in Korea up to 9 December 1950 as gleaned from Daily Intelligence Summaries. These summaries prove to be inadequate for the location of lucrative troop targets. (d) Annex 4 discusses the location and evaluation of personnel targets by aerial photography. It is shown that it is possible to set up a system that will operate with available equipment and furnish reliable data on troop movements and personnel targets. An experiment was carried out with known numbers of personnel in various kinds of cover to determine how accurately it is possible to estimate number of troops. These estimates are reliable only when made from photographs on a scale of 1:2,000 in place of the present 1:5,000 or 1:7,500. The necessity for establishment of a Joint Intelligence Center (JIC) to integrate photo reconnaissance, photo interpretation, and intelligence is demonstrated.

Joint Staff Problems (Appendix D)

16. Preparation for atomic warfare will require changes in organization and procedures of general, special, and joint staffs at field army, tactical air force and corps levels. The primary purposes of such changes will be: to integrate combat operations and intelligence processes for the speedier recognition and evaluation of targets and for faster and more precise operational planning; to coordinate and control attacks against enemy targets with atomic or other weapons in close support of ground forces; to develop

methods of post-strike reconnaissance for exploitation; and to increase the safety of friendly troops from both friendly and enemy atomic attacks. This appendix proposes the establishment of a Joint Intelligence Center (JIC), the organization of Joint Atomic Warfare Advisory Groups (JAAG), and the integration of these units with existing Joint Operations Center and Tactical Air Control System into a coordinated system called JOINT TACTICAL WEAPONS CONTROL SYSTEM. The appendix also recommends that joint staff officer training sections be formed and assigned immediately to Korea for the purposes of studying, developing, practicing, and evaluating staff procedures in simulated atomic attacks under actual combat conditions.

17. In an annex to this appendix, a discussion is presented of a large target of opportunity from 7 to 11 February 1951 in the neighborhood of Chipyong-ni. The development and recognition of the target, and the operational action resulting in attack by bombers are traced.

Means of Delivery (Appendix E)

18. The delivery of atomic weapons by tactical air, guided missiles, artillery, and medium bombers is analyzed.

Command and Logistics For Delivery by Medium Bombers (Appendix F)

19. The organization of command and logistics that will be needed to plan and execute tactical atomic attacks by medium bombers is discussed.

20. Three annexes provide special consideration of the following: (1) an estimate of the time required for decision and delivery, (2) a check list of elements in flight preparation and delivery, and (3) methods for possible reduction in delivery time.

Vulnerability of UN Ground Forces (Appendix G)

21. Four annexes to Appendix G describe actual situations in which UN ground forces were vulnerable to atomic attack and describe the results that might have been achieved if such attacks had been carried out:

(1) On the front of I and IX Corps on 31 December 1950, the employment of sixteen 40-KT atomic air bursts would have destroyed completely the combat effectiveness of both Corps.

(2) One 40-KT atomic air burst at Taegu at any

time during the period December 1950 to March 1951 would have completely destroyed both Fifth Air Force and Eighth Army Headquarters and would also have produced heavy damage on K-37 airfield.

(3) Five 40-KT atomic air bursts delivered at night would have destroyed 99 percent of all aircraft based in Korea if delivered on or about 31 December 1950 on the principal Korean airfields of Fifth Air Force.

(4) The port of Pusan on 16 October 1950 was especially vulnerable. Three atomic bombing patterns of one to five bombs each would have destroyed: (1) the logistical base of the Eighth Army and Fifth Air Force; (2) the port facilities; (3) a major fraction of a fleet of 112 ships with cargo and a large percentage of embarked X Corps personnel.

Personnel Injuries and Medical Requirements (Appendix H)

22. Eight types of casualties from atomic air bursts are discussed, and their impact on medical requirements for the military is considered. A number of suggestions are made for improving medical facilities in anticipation of tactical atomic warfare.

Comparison With Other Weapons (Appendix I)

23. Atomic weapons are compared with other weapons in offensive situations, with respect to effort and cost for equal effectiveness. It is shown that atomic weapons are superior to other weapons for neutralizing large army targets.

Indirect and Non-Material Effects (Appendix J)

24. Tactical use of atomic weapons can have such indirect effects as (a) civilian casualties, (b) value in exploitation and extrication, (c) changes in enemy tactics and dispositions, (d) psychological effects on enemy troops, (e) impact on enemy politics and the international situation, (f) effect on enemy estimate of our supply of atomic weapons, (g) possible change in the deterrent value of our known atomic capability. Each of these indirect effects is discussed briefly. A translation of a captured communist indoctrination booklet on atomic energy is included as an annex.

CONCLUSIONS

25. During the period covered by these studies, the Chinese Communist Forces and the North Korean Army were on the offensive. They have offered a considerable number of lucrative troop targets for which the assessed casualties would average 2,000 to 3,000 killed and an additional equal number seriously wounded per atomic warhead expended.

26. Offensive troop concentrations reach maximum vulnerability at jump-off. Thus, the CCF breakthrough on the I and IX Corps sectors of Line Baker could have been changed into a disastrous CCF defeat by the timely use of six atomic air bursts over pre-selected aiming points shortly before midnight on 31 December 1950.

27. On the average, UN forces on the defensive would have suffered casualties of 1,000 to 1,200 killed and an equal number of seriously injured per atomic weapon expended against these forces.

28. In addition to UN front-line and reserve troops, all supply ports, principal depots, POL, aircraft and airfields, and corps and army headquarters of the UN forces in Korea are highly vulnerable to disaster through atomic attack. This vulnerability is further magnified by the nearly complete lack of atomic indoctrination among junior officers and enlisted men, and by the absence in the theater of medical supplies and facilities adequate for the treatment of atomic casualties.

29. Both in cost and in effectiveness, carpet bombing and area artillery fire fail by large factors to compete with atomic weapons as a means for attacking large area ground-force targets.

30. Present intelligence procedures are adequate only for stable or quasi-stabilized situations near friendly MLR. They are inadequate to establish the existence of large targets of opportunity, such as reserve troop concentrations, in time for atomic attack.

31. It has been demonstrated by tests over both friendly and enemy troops that dependable estimates can be made of troop targets in Korean terrain and cover by aerial reconnaissance photographs at a scale of 1:2,000.

32. The time required at present between the identification of troop targets and feasible strikes by medium bombers flying from distant airfields would have prevented timely atomic attacks on an important fraction of all CCF

SUMMARY

and NKA troop targets.

33. Korean roads, bridges, and terrain would not have permitted effective use of heavy field guns, such as the 280-mm gun, to fire atomic projectiles against CCF and NKA troops.

34. No adequate equipment has been available in the theater for target designation guide- and track-in, and ground control of close-support aircraft, so that the delivery of atomic weapons within the bomb line would have been unduly hazardous to friendly troops. However, it is believed that suitable equipment could be readily developed or adapted from existing radar and VHF radio navigation aids.

35. The operations and intelligence staffs of the army and air force in Korea are not organized or prepared to plan or execute effective atomic attacks against ground force targets.

RECOMMENDATIONS

36. The army should plan for 10 atomic warheads per opposing enemy division, of which approximately half would be used directly against enemy troops and half against his support and services.

37. Phase III of the DA atomic indoctrination course should be completed for all junior officers and enlisted men in order to prepare them for self-protective measures in the event of atomic attack. Adequate training, or replacement by trained personnel, should be provided for radiological officers in the field.

38. Army medical depots should pre-package for air shipment medical supplies specially adapted for casualties resulting from atomic warfare.

39. Atomic warheads for delivery by fighters, light bombers, or guided missiles operating from airstrips or launching sites located in corps area should be provided in order to minimize delivery time of atomic weapons.

40. Staff officer training sections should be established and assigned to Korea as soon as possible to develop staff procedures appropriate to atomic warfare by planning, coordinating, and evaluating simulated atomic attacks under actual combat conditions.

41. A Joint Intelligence Center (JIC), to work in close

cooperation with JOC, should be established.

42. Joint Atomic Advisory Groups (JAAG) should be established at theater, field army, and corps headquarters.

43. A JOINT TACTICAL WEAPONS CONTROL SYSTEM should be organized to: integrate the functions of proposed JIC, and JAAG, and existing JOC and Tactical Air Control System; and to coordinate and control atomic attacks (or other close support operations) delivered by army or air force units.

TACTICAL EMPLOYMENT OF ATOMIC WEAPONS

This document contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

TACTICAL EMPLOYMENT OF ATOMIC WEAPONS

INTRODUCTION

1. The problem is to study the tactical employment of atomic weapons for the support of ground forces. Korea has served as a laboratory and the Korean Campaign as laboratory material to add realism to studies which heretofore have been mostly hypothetical.

2. Atomic weapons offer means for neutralizing large areas with maximum surprise, thorough coverage, and minimum effort. Consequently, the tactical employment of atomic weapons in appreciable numbers is practically certain to force changes in army training, organization, equipment, logistics, intelligence and tactics. Atomic warfare also has the intrinsic capacity to generate changes in both the strategic and the tactical concepts of Army's role in national defense.

3. It is the purpose of the present report to review and analyze tactical atomic warfare in a preliminary but reasonably comprehensive manner. Pending the actual use of atomic weapons in tactical support of ground force operations, there is real danger that a report of this kind will raise unnecessary questions, belabor trivial points, infer impracticable solutions, or draw false conclusions. Consequently, the studies presented in the various appendices and annexes of this report are illustrated wherever feasible by examples drawn from the Korean Campaign. It follows that even though the analyses, conclusions, and recommendations presented herein must of necessity remain largely hypothetical, they do nevertheless possess verisimilitude, and merit some further study by the Army staffs explicitly concerned.

FACTS

4. No atomic weapon ever has been used in direct support of ground forces. However, the physical effects of atomic weapons, as contained in data issued by the United States Atomic Energy Commission, can be used as the basis for estimating casualties to personnel and damage to materiel in tactical atomic warfare.*

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* The Effects of Atomic Weapons, Atomic Energy Commission, September 1950, is based on 20 KT weapons. The nominal atomic weapon used in this report is equivalent to 40 KT (kilotons) of TNT, but scaling laws for other KT equivalents are given.

5. The logistical and tactical practices of CCF, NKA, and UN forces in Korea are not necessarily typical of other armies and other theaters, but they do lead to prototypes of a wide variety of realistic targets against which the effects of atomic weapons can be assessed.

6. The major military powers of the world have the technical and economic capabilities that will permit manufacturing and stockpiling, first hundreds, and later, thousands of atomic weapons for tactical use. However, no assumptions are made with respect to any high-level plans or decisions already made, or which may be made, on the allocation of atomic weapons to tactical employment.

SCOPE

7. The present report is concerned only with the tactical use of atomic weapons against friendly and enemy ground force targets in or near the combat zone.

8. Alternate and possibly competitive uses by Navy or Strategic Air Commands, and associated problems of production, allocation, and stockpiling, are not considered.

9. The effects of atomic warfare upon civilian populations may be found in publications of civilian defense organizations, and are beyond the scope of the present report, except to the degree that the presence of friendly populations in the combat zone may influence military decisions.*

10. The report considers only atomic explosives. That is, no discussions are given on the radiological warfare branch of atomic warfare except to the extent that troop casualties may result from neuclear radiation, fission products, and radioactive by-products produced by atomic explosions in the air, on the surface, underground, or underwater.

11. The use of a nominal 40-KT equivalent weapon in this report should not be taken as an indication that this is either an ideal or a general-purpose size for tactical atomic weapons. The body of data upon which inferences, conclusions, or recommendations concerning an atomic weapons family might be based are beyond the scope and classification of this report.

DISCUSSION

Physical Effects

12. Sources of Information. The physical effects of

* See Appendix J, "Indirect and Nonmaterial Effects of the Employment of Atomic Weapons in Support of Ground Operations."

atomic weapons are known in a preliminary way from low air-burst tests of atomic weapons and from the Hiroshima and Nagasaki experiences. The three principal forms of energy release from an atomic explosion in the air are air blast, thermal (heat) radiation, and penetrating gamma radiation. These overlap considerably in distance and degree of damage, but once their ranges and magnitudes have been measured in full-scale tests, they can be duplicated, with reservations as to similitude, at smaller scales in the laboratory or in the field.

13. There is great need for tests on underground and surface atomic explosions, about which almost nothing is known, and for further scientifically planned test data on a wide variety of actual atomic bursts and simulated burst effects at smaller scales to establish tighter limits of confidence for estimating damage to personnel, materiel, equipment, structures, and installations.

14. Most of the needed data are of a fundamental nature which would meet joint requirements for Army, Navy, Air Force, and Civil Defense in the whole region from the combat zone to the zone of the interior, and for strategic as well as for tactical purposes.

15. Scaling Laws. Appendix A discusses the physical effects of 40-KT air-burst atomic weapons, outlines the probable effects of 20-KT surface and underground bursts, and states scaling laws for extending these effects to weapons of other KT equivalents. Atomic weapon effects scale accurately for blast, but only approximately for radiation effects, by $W^{1/3}/L$, where W is the total energy release and L is distance from burst point. This means that each time the energy release is doubled, the range to which a given effect extends is increased by approximately 26 percent, and and the affected area is increased by 59 percent, approximately.

16. The feasible range of atomic weapons energies, to which results of the present studies may be applied through the use of appropriate scaling laws, extends from perhaps 5 KT to over 100 KT.

17. Modifying Factors. In addition to the obvious dependence on total energy release, the physical effects of atomic weapons may be altered by many other factors; by the height of burst, by local terrain and (sometimes) geology, by natural and artificial cover, by meteorological conditions, by the choice of aiming points, by friendly and enemy tactics, and by the accuracy and timeliness of weapon delivery. Most of these factors are interdependent and of familiar character in the employment of conventional weapons.

18. In general, but with certain sharp exceptions, it probably will be easier to take these factors into account in planning for the efficient use of atomic weapons than in planning for the efficient use of conventional weapons. Since these factors are themselves functions of training, tactics, organization, and equipment, and of tactical intelligence, combat operations, and supporting logistics, a fuller discussion of them constitutes the scope of this report. We return now to the discussion of physical effects.

19. Effects of Terrain. A somewhat unanticipated result of Korean studies, where a major fraction of terrain is rough to mountainous, is that terrain need not have more than minor significance in limiting atomic weapon effectiveness. There are three reasons for this: ordinary dominant terrain features, such as 500-foot hills, are small in the scale of the effective range of atomic weapons; major terrain features limit both tactical deployment and freedom of movement in a manner tending to define boundaries for major targets such as important reserve or assembly areas, bottlenecks on MSR (Main Supply Routes) and deployment in force along MLR (Main Lines of Resistance); major and critical terrain features, such as key positions on commanding heights, are important enough to be singled out for atomic attack. In other words, contrary to naive expectation, major terrain features probably may increase the ease of employing atomic weapons effectively, and the more puzzling cases may involve featureless, rolling or flat terrain in which diffuse deployment in combination with free lateral movement and rapid concentration of forces can proceed unhampered by major streams, ponds, swamps, heights, valleys, routes, defiles, towns, junctions, or other obvious concentration boundaries and route bottlenecks.

20. Effects of Meteorology and Cover. Major terrain features, discussed above, tend to determine target boundaries and the choice of aiming points. Conditions of artificial and natural cover and of local meteorology define the approximate choice of burst heights (including choice between air, surface or underground bursts) and the spacing between aiming points, if an appreciable area is to be attacked.

21. Meteorological conditions limit the range of primary target damage by direct thermal radiation and the extent to which secondary damage may be caused through the ignition and spread of holocaust fires in combustible materials. Meteorological conditions thus constitute a sort of transitory cover for protection against thermal radiation.

22. Natural and artificial cover (trees, buildings, gullies, trenches, etcetera) set approximate limits to the

optimum burst-heights required to maximize the range from ground zero at which shade from thermal radiation and resistance to blown-down become effective.

Target Vulnerability Classes

23. The modifying factors of meteorology, cover, and to some extent, terrain, can be combined in defining the approximate ranges and areas over which atomic weapons may inflict various degrees of damage (Table I).

24. Within the accuracy of present knowledge of the probable physical effects of atomic weapons, most "soft" ground-force targets arbitrarily may be divided into three classes of decreasing vulnerability, designated classes A, B, and C. Illustrative examples of each class* are as follows:

a. Troops in march, or at jump-off; troops in the open during clear weather; troops under poor cover at any time, are of Class A vulnerability for atomic attack.

b. Troops in static positions with shallow to average protection by entrenchment during good weather; prone troops in the open during hazy weather, are Class B targets.

c. Troops under good cover, such as meteorological cover in the open during extremely hazy conditions of fog or rain; troops forwarned in time to reach prepared shelter; indoctrinated troops in deep entrenchments at zero time, are Class C targets.

25. In Table I, it will be noted that the less vulnerable targets differ least from the more vulnerable targets in the size of the area of heavy damage, and most in the size of the area of light damage. That is, types of cover normally available to ground forces will not protect personnel in the neighborhood of ground zero.

26. Burst Heights. It always is possible to choose a burst height (or depth) which will maximize the target area receiving any desired type and degree of damage from a single agent such as air blast or ground shock. It usually also is possible to choose a burst height which tends to maximize the area receiving damage from the combined effects of two or more agents, such as combined damage from air blast and thermal radiation.

* See paragraph 84, Appendix A for a more complete definition of Target Vulnerability and paragraph 6, Appendix B, for a list of 22 targets in descending order of "soft" to "hard."

TABLE I

DEGREE OF DAMAGE* TO PERSONNEL BY

40-KT AIR BURSTS AT 3,000 TO 3,500 FEET

HEIGHTS AGAINST CLASS A AND B TARGETS,

AND 2,500 TO 3,000 FEET HEIGHTS AGAINST CLASS C TARGETS

Vulnerability Class	DEGREE OF DAMAGE					
	SEVERE		MODERATE		LIGHT	
	Radius (yds)	Area (Mi^2)	Radius (yds)	Area (Mi^2)	Radius (yds)	Area (Mi^2)
A	2100	4.4	3250	10.6	4300	18.5
B	1750	3.1	2550	6.5	3400	11.6
C	1500	2.3	2050	4.2	2700	7.3

Vulnerability Class	LIMIT OF DAMAGE***		Average % Casualties Within Damage Area	Comparative Casualty Totals**
	Radius (yds)	Area (Mi^2)		
A	5250	27.6	37	10,000
B	4050	16.4	42	7,000
C	3150	9.9	50	5,000

* Degree of damage to personnel is defined as follows:

Severe: The least distance from ground zero at which no more than 50 percent are killed and most survivors are incapacitated.

Moderate: The distance at which deaths have fallen to 5 percent and about half are incapacitated.

Light: The distance at which about 5 percent are incapacitated and very few are killed.

** Based on 1,000 men per square mile.

*** Limit of damage: The least distance beyond which none are killed and injuries are negligible.

DISCUSSION

27. For 40-KT weapons, the burst height for maximum damage to Class A and B targets is 3,000 to 3,500 feet; the burst height for Class C targets should be lowered to between 2,500 and 3,000 feet if a maximum area is to be damaged. An exact choice of burst height, however, usually is not critical since variations of plus or minus 10 percent from the optimum burst height do not appreciably change the area of damage to soft targets by air bursts.

28. Surface and Subsurface Bursts. Targets harder than Class C probably can be more effectively attacked by surface or subsurface bursts than by air bursts. These harder targets include such tactical targets as major fortifications, railroad tunnels, defiles, dams, canal locks, and the like. The extent of the area damaged mechanically by cratering, throw-out, and ground roll, and the hazards of radioactive contamination are conjectural pending full-scale tests.

Comparison with Alternative Weapons

29. Neutralization of Large Areas. Atomic weapons are essentially area weapons. In ground-force operations, they offer for the first time available means for attacking very large areas, including enemy's rear, with maximum coverage of targets by attacks delivered in minimum times by minimum forces. That is, atomic weapons can be used by small friendly forces to exploit maximum surprise and saturation in the destruction of large enemy forces. Thus, the analysis of Appendix I demonstrates that large mixed Class A and Class B targets, covering total areas of from 300 to 1,100 square miles, can be neutralized with 70 atomic weapons (40 KT each) in the same time and by the same force of 70 B-29 medium bombers required to neutralize a 4-square-mile area with conventional explosives.

a 90-300 x more powerful

30. Or, a single aircraft can neutralize a troop target as large as 16 square miles with a 40-KT atomic weapon at least as readily as it can neutralize a 0.06-square-mile portion of the same target with conventional explosives, provided of course that such targets can be located and identified. Furthermore, Appendix I also shows that if a troop concentration, about a square mile in area, has been pinpointed for attack, and the target center before attack moves laterally as much as 2,000 yards while the whole concentration disperses radially by as much as 4,000 yards, a 40-KT atomic weapon delivered on the original aiming point would still be effective, in contrast to an attack with conventional explosives, which would be almost entirely wasted. That is, tactical intelligence problems, discussed below, often will be simplified by the employment of atomic rather than conventional explosives.

3[illegible]. Relative Costs. The total cost of delivering conventional explosives on an extensive target area are large compared to the original production cost, while for atomic weapons, the reverse is true. The actual production costs of atomic weapons are of higher classification. However, Appendix I demonstrates, on the basis of a few reasonable assumptions, that it will be cheaper in terms of total dollar cost to employ atomic weapons rather than conventional explosives when it is desired to produce at least 30 percent casualties over an area of mixed targets of Class A and Class B vulnerability:

a. If the target is 0.5 square miles or larger, then atomic weapon attacks will be less costly than attacks by medium bombers with conventional weapons;

b. If the area is 3 square miles or larger, then atomic weapons will be cheaper than 105-mm artillery.

3[illegible]. From a somewhat different approach, it can be argued that the dollar cost of producing an enemy casualty is roughly the ratio of the total dollar cost of conducting a ground force campaign to the total number of casualties inflicted on the enemy. On this basis, the cost of producing an enemy casualty exceeds $50,000. The $2,500,000 cost assumed in Appendix I for producing and delivering an atomic weapon obviously should not be extended to justify the tactical employment of atomic weapons on a basis of 50 enemy casualties per weapon expended, but the comparison does indicate that dollar cost can not be the controlling factor in the employment of atomic weapons against tactical targets.

3[illegible]. There are two additional factors which have bearing on the comparative costs of atomic weapons and alternative conventional weapons:

a. The surveillance and maintenance costs of an adequate supply of ready ammunition and of stock-pile reserves are far less for fissionable materials than for conventional explosives.

b. The cost for modernizing obsolescent stock-piled weapons would be less for atomic weapons than for conventional weapons because of the much smaller number of units requiring modification or replacement.

Vulnerability of Friendly and Enemy Forces

3[illegible]. Situations Examined. A study of the deployment of friendly and enemy forces in Korea indicates that both sides have been vulnerable continuously to atomic attack.

DISCUSSION

A number of illustrative examples are included in the various annexes to appendices in this report. They illustrate such situations as: defense of a stabilized friendly MLR; attack on a friendly supply port; strike against friendly transports and cargo vessels; simultaneous destruction of friendly tactical aircraft, airfields, and/or runways; neutralization of an enemy troop-assembly area; defeat of an enemy concentration attacking a friendly salient; exploitation of an enemy target of opportunity; elimination of an enemy corps in close reserve; preparation for enemy break-through against friendly MLR; interdiction of MSR, and defense of a friendly perimeter. Except for the last-listed defense of a perimeter, all of the situations are real situations drawn from the Korean Campaign between late November 1950 and early February 1951.

35. Comparative Vulnerability. All enemy situations are subject to uncertainties in intelligence, as discussed later. Friendly ground situations can be analyzed in the detail made possible by access to friendly records and overlays. Thus, access to friendly ground situation maps has made it evident that lucrative friendly personnel and materiel targets for atomic attack have existed at all times, but lesser knowledge of enemy situations has only revealed a limited number of enemy troop targets (and no worthwhile materiel targets) vulnerable to atomic attack at specific times or during short periods of a few days.

36. It is not felt that this means that enemy troop targets have occurred less often than friendly ones. Studies of CCF tactics* indicate that on the average enemy troop concentrations probably are as numerous as and denser than friendly concentrations.

37. Enemy Logistics. Enemy's logistic system, on the other hand, has had no major supply centers and depots in Korea comparable to the friendly concentrations at Pusan or ASCOM CITY.** This is due only in part to his more primitive logistics and his deficiencies in supplies and equipment. It probably is more largely due to his ability to keep his principal logistics centers behind the Yalu River "King's X" line and thus unrealistically immune to either reconnaissance or attack.

38. Friendly Logistics, Support and Command. In contrast to CCF and NKA, all UN supply ports, embarkation vessels, principal depots, POL, tactical aircraft and airfields, communication centers, and corps, army, and tactical air force headquarters in Korea have been highly vulnerable to

* See Appendix B; also Appendix C, Annex 1, paragraph 26.
** A primary Army Service Command depot, west of Seoul.

disaster through atomic attack throughout the period examined (October 1950-February 1951). These installations, except for corps headquarters, have been relatively fixed and could have been (and probably were) known to enemy intelligence. A detailed discussion is given in Appendix G.

39. Casualties per Weapon Expended. Estimates of enemy troop casualties have been made for four ground situations involving the expenditure of 15 atomic weapons as follows:

a. CCF 66th Army (Corps) in Taechon area on the night of 24-25 November 1950. Estimated casualties from one 40-KT air burst, 15,000 of a total enemy force of about 22,000. Situation: dense enemy concentration of about 2700 troops per square mile in close reserve; nearest friendly forces 5 miles; light patrol contact. Limitation: time required to confirm intelligence and deliver attack by medium bomber probably would have prevented exploitation before target moved 25-26 November.

b. CCF and NKA troop assembly in Pyonggang-Chorwon-Kumhwa triangle on 27-29 December 1950. Estimated casualties from six 40-KT air bursts, 30,000 to 45,000 of a total enemy force of 65,000 to 95,000. Situation: enemy concentrations centered around towns, villages, and road net in a 200-square-mile area 20 to 35 miles from friendly lines; no contact; enemy preparing to move S and SE to attack UN Line Baker along 38th parallel. Limitations: probable locations of enemy determined with sufficient accuracy by terrain, shelter, and roads; friendly intelligence on enemy numbers was somewhat inexact and was received while target was dissipating.

c. CCF build-up along line north of the Imjin River, late December 1950. Estimated casualties from six 40-KT air bursts on night of 31 December-1 January, 28,000 to 40,000 of a total enemy force of 70,000 to 100,000 in target area. Situation: enemy assault in force; enemy jump-off following probing attacks, preceded by several days of patrol contact. Limitations: none of consequence; chief uncertainty in casualty estimate lies in how many close reserves joined 70,000 established in target area.

d. NKA concentration against Wonju salient, 7-8 January 1951. Estimated casualties from two 40-KT air bursts, 6,000 to 9,000 of a total enemy force of 18,000. Situation: enemy pressure on friendly key point; intermittent contact in patrol to battalion strength. Limitations: uncertainty as to boundaries of enemy concentration except where determined by terrain; unfavorable weather except for 3-hour period after 1800 on 8 January.

DISCUSSION

40. Probable casualties to friendly troops can be estimated with more confidence than for enemy forces because accurate knowledge of strengths and deployments is readily obtainable in the field. A detailed study of UN deployments from corps to front line was made for the I and IX Corps sectors for 31 December 1950. The estimated friendly casualties from a pattern* of 16 40-KT air bursts was 2400 per weapon expended. Concentrations were about 50 percent of SOP "by the book" at the time, but this is usual in the Korean Campaign. Cursory examination of other ground situations indicates that on the average UN casualties would be 2,000-2,400 per air burst.

Command and Staff Problems in Tactical Atomic Warfare.

41. Enemy Targets. On the basis of friendly knowledge (G-1, G-3, and G-4 staff records), it is obvious that lucrative friendly troop targets for atomic attack are continually present. It follows from our general knowledge of enemy tactics and practices that the same must be true for enemy forces. The primary question is: How can friendly intelligence and operations devise methods and procedures to locate and evaluate these enemy targets in sufficient time to plan and deliver atomic attacks against them?

42. Problems in Friendly Intelligence and Operations. Appendix C presents a detailed discussion of intelligence problems in relation to tactical atomic warfare. The joint combat intelligence-operations relationship is further discussed in Appendix D.

43. The Rear Area Problem. Perhaps the most significant change that the tactical employment of atomic weapons may introduce is a means for decisively attacking substantial numbers of enemy troops prior to their firm contact with friendly forces. Previously, enemy's training, bivouac, reserve, and assembly areas, his logistics and supporting services, his MSR defiles, his tactical airfields, and his communication and command centers have been located in rear areas relatively free from attack, except by casual and occasional tactical bombing or strafing, because they generally have been beyond artillery range. In consequence, their locations and sizes have been of minor interest to intelligence except in terms of approximate strengths and times of march for intervention in ground actions. Atomic weapons now present

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* To avoid prejudicing the data, this pattern was laid out on the basis of terrain, shelter, roads, and other considerations presumed available to the enemy. Detailed knowledge of friendly strengths and positions then was applied in estimating casualties.

a means for attacking these rear area targets without committing friendly forces or incurring unfavorable ratios in casualties. Hence, new intelligence procedures will be required for more exact target definition in enemy rear areas, and counterintelligence must find ways to prevent enemy intelligence acquiring similar information on friendly areas.

44. Intelligence Accuracy. Tactical atomic warfare does not appear to introduce any unusually exacting requirements for accuracy in intelligence. Since atomic weapons are suitable for the neutralization of considerable areas, targets do not require pin-pointing to the extent necessary for conventional weapons. From the various examples given in appendices and annexes, it is clear that the primary requirement is to establish that either the total number or the average density of troops or other targets in the target area is sufficiently large to make an atomic attack worthwhile

45. There are three principal faults in present intelligence procedure which prevent minimum standards of accuracy being reached, particularly with respect to enemy rear areas:

a. Failure to specify numbers or even probable upper and lower limits for numbers. Thus, in a study of 3,081 intelligence items for a 97 day period,* it was found that a total of 1,434, or 46 percent of all cases, were reported as "strength unknown."

b. Failure to indicate whether a report of enemy units may or may not duplicate a prior report. This fault could be eliminated by establishing and reporting the probability of duplication. Such commonplace procedures as immediate follow-up on trigger intelligence, continued surveillance of sighted enemy units, maintenance of plotting boards on rates and directions of movement, and the construction of accumulation charts are applicable and should be used more generally. At present, it appears that too much dependence is placed on order-of-battle procedures which can only establish general trends, with the result that large CCF units have repeatedly appeared and disappeared despite their ponderous movement.

c. Failure to capitalize on or improve available equipment and procedures. It is unlikely that any radically new means for collecting intelligence will be invented; the more effective use of existing techniques is indicated. This requires alertness to possible improvements and analysis to establish reasons for failures. Thus, Annex 4 of Appendix C demonstrates a means for markedly improving photo intelligence

* Appendix C, Annex 3, paragraph 3.

DISCUSSION

methods for locating troop targets which had worked after a fashion in the European Theater of Operations but failed completely in Korea.

46. Timely Intelligence. The Korean Campaign has made it evident that many intelligence reports are relayed and processed too slowly to be used in atomic warfare. Although this is more generally true for intelligence from rear areas, it also frequently has occurred in unstabilized contact situations.

47. Operations Planning. To a lesser degree than for intelligence, improvements in accuracy and timeliness will be needed in planning, delivering, and exploiting atomic attacks. In fact, improvements in speed and precision in processing intelligence and in planning operations also are needed by mechanized ground forces and in tactical air operations.

Changes in Staff Organization and Function

48. Some of the required speed-up in intelligence and operations can be gained by improvments in techniques and procedures, but it is felt that the larger gains can be made by changes in organization and in communications. The reasons for this view are developed in detail in Appendix D.* In outline, these reasons are as follows:

a. There already exists a pressing need for a Joint Intelligence Center (JIC) for joint army-tactical air operations. This need will be further increased in tactical atomic warfare because aerial reconnaissance will be extensively used for both pre-strike and post-strike intelligence.

b. A large fraction of the atomic weapons used in support of ground operations will be delivered by tactical aircraft so that close coordination between ground and air will be required.

c. Regardless of the method of delivery, the tactical use of atomic explosives will involve the joint safety of friendly troops and friendly aircraft.

d. Present intelligence processing is too slow, both vertically and laterally, but particularly so in army-tactical air force liaison channels and in problems of joint interest.

e. There is considerable overlapping in the functions and cognizance of combat operations and combat -

* Appendix D, paragraphs 5-18 and 36-57.

intelligence at field army, tactical air force, and corps levels. The present organizational separation of these functions in general staffs at these levels is artificial, and tends to create rather than solve problems in coordination and cooperation.

f. The logical place to integrate as many as feasible of desirable changes or additions in joint organiza tion and function is the Joint Operations Center (JOC).

g. Any changes or additions in organization or function made in anticipation of tactical use of atomic weapons should be compatible with the efficient use of all other air-ground and ground-ground weapons.

49. The analysis outlined in the preceding paragraph suggests and supports the following four proposals:

a. Amplification of the functions of the present Tactical Air Control System.*

b. Increase in the functions of the Joint Operations Center;* particularly, the addition of a Joint Intelligence Center and an integrated joint communications network under JOC direction.

c. The organization of a <u>combined</u> G-3/G-2 combat operations section under a single assistant chief of staff in the general staffs at field army and corps levels.

d. The organization of a JOINT TACTICAL WEAPONS CONTROL SYSTEM, similar to the one suggested in Figure 1 of Appendix D, to integrate the functions of items (a), (b), and (c) above, and to coordinate and control atomic attacks (or other close support operations) delivered by army or air force units.

50. It is believed that a system similar to the proposed JOINT TACTICAL WEAPONS CONTROL SYSTEM is compatible with procedures recommended in the Joint Training Directive and that it would aid in the more effective use of both conventional and atomic weapons.

51. <u>Various Means of Delivering Atomic Weapon Attacks</u> The preceding proposal for a JOINT TACTICAL WEAPONS CONTROL SYSTEM is made in anticipation that new means of delivering atomic weapons attack will be developed.** These presumably

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* "Joint Training Directive for Air-Ground Operations," Office of the Chief of Army Field Forces and Headquarters, Tactical Air Command, September 1950.

** See Appendix E.

will include atomic projectiles fired by heavy artillery, surface-to-surface and air-to-surface guided missiles and rockets, and weapons suitable for delivery by tactical aircraft such as light bombers and fighters. The development of such weapons and their allocation to field army, tactical air force, and/or corps areas would materially decrease the present objectionally long time (12 hours or more) estimated to be required to plan and deliver atomic-weapon attacks by medium bombers.*

52. Other Command and Staff Problems. There are four new requirements, discussed in Appendix D, which army and tactical air commands and general staffs should anticipate in preparation for atomic warfare.

a. Organization and training of general and special staff officers in the procedures and techniques of atomic ~~warfare.~~ It is felt that this requirement can best be met by organizing Staff Officer Training Teams and sending them immediately to Korea to study, practice, and evaluate staff procedures in simulated atomic attacks under actual combat conditions. As an interim measure, pending the training of an adequate number of such teams, Joint Atomic Warfare Advisory Groups (JAAG) would need to be assigned to general staffs in the event of atomic warfare.**

b. Organization and training in combat operations for personnel who will participate in atomic attacks. Here again, it is believed that this requirement could best be met by actually planning, executing, and testing as many of the phases of combat operations as feasible in Korea, utilizing conventional explosives, if possible, in otherwise fully realistic atomic attacks on real targets. This procedure would provide both realistic tests of combat techniques and a body of experienced personnel for training additional combat officers, troops, and airmen.

c. Indoctrination of all personnel in safety procedures and methods of self-protection. This indoctrination should be given immediately as a part of basic training for new recruits, and plans should be made to indoctrinate army personnel in Korea, most of whom have not completed indoctrination.***

d. Staff preparation for the assignment and utilization of the new units and services required by atomic warfare.

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* See Appendix F, particularly Annex 1.

** See the organization diagrams and discussion in Appendices D and F for description of JAAG functions.

*** See Appendix H, Annex 1, for a suggested emergency plan of indoctrination.

Medical Requirements

53. Present medical equipment, supplies, and facilities in the army are geared to the requirements of warfare with conventional weapons. Requirements for atomic warfare are discussed in Appendix H. The saturation of medical facilities, combined with their partial destruction, with radiation sickness, and with large increases in the ratio of burned to mechanically injured casualties must be anticipated. The ratio of dead to injured will approach 1:1 instead of the present ratio of 1:4.

54. Logistics officers will need to prepare for the evacuation of large numbers of wounded and for emergency airlifts of medical personnel and supplies to atomic disaster areas.

Changes in Tactics and in Field Equipment

55. Appendix B presents a discussion of some of the tactics appropriate to atomic warfare, and most of the annexes to the various appendices of this report also are pertinent. Even if changes in major tactics were not made in anticipation of atomic warfare, the initial use of atomic weapons in ground operations appears certain to generate immediate and significant changes in both friendly and enemy tactics and in field equipment to make it more appropriate to the new tactics.

56. The general nature of some of these tactical changes can be forecast from a knowledge of atomic-weapons effects combined with analyses of friendly or enemy vulnerability in various real or assumed ground situations. For example, the following changes in tactics and equipment are likely to occur because they appear to reduce vulnerability to defeat through atomic attack:

this is 7 years before Kissinger!

a. Less emphasis on massive concentrations. When large concentrations are employed, they are likely to assemble from units arriving on times and lines of march calculated to bring them quickly into assembly and thence into immediate contact.

b. Increased emphasis on mechanization, mobility, and frequent movement.

✓ then ×

c. More general use of smaller, self-contained mechanized units, task forces, or combat teams of battalion to regimental size.

×

d. Increased requirements for mechanized replacement and special-purpose units.

✓ = happened × = little actual Δ over time.

e. More radio and messenger, and less wire communications in the field.

f. Decrease in trailed artillery and increased dependence on light armor, tanks, and self-propelled guns with more or less complete splinter shielding on the side and thermal shielding overhead.

g. Increased use of camouflage, concealment, and night movement.

h. General dispersal of troops and materiel in training, reserve, and bivouac areas.

i. More emphasis on immediately digging-in in rear as well as forward areas, possibly combined with the use of light top-cover for thermal shielding and camouflage.

j. Rather complete changes in current doctrines for beach-, bridge-, and airhead operations.

k. Individual, spaced tactical airfield runways and greater dispersal of grounded tactical aircraft.

l. Increased responsibilities for company and field grade officers.

m. Possible replacement of one or more of the present field command echelons by task force coordination centers.

n. Increased use of aerial reconnaissance and armored ground patrols to seek out enemy units.

o. Greater likelihood of major sabotage in rear areas by guerrillas and airborne intruders.

57. It cannot be said with certainty which of these changes will occur nor which will be most effective. For example, if tests show that surface and subsurface bursts are not as effective as expected, dug-outs and deep fixed entrenchments with comparatively static lines, like those of World War I, might return to favor and thereby shift some of the emphasis from atomic explosives to radiological and chemical agents as potent area weapons against static positions. In either case, the use of small, dispersed strong points and reinforced emplacements is not ruled out.

58. Other Tactical Factors. In addition to the staff problems in intelligence and operations outlined previously, there will be requirements for evolving procedures and tactics

by which suitable atomic targets may be anticipated or induced. There will also be a number of technical requirements which tactical operations must be prepared to meet. Most of these are common to the use of all weapons, but some assume special importance in atomic warfare.

59. Once a target has been evaluated and marked for attack in a close support operation, the primary requirement will be to assure delivery accuracy and the safety of friendly personnel. Appendix B describes some applicable target-marking and local ground-control systems, and develops arguments to show that two separate ground stations are required: one for target marking or guide-in, the other for track-in and approval of weapon release (or arming) after the atomic weapon safety line is crossed.

60. Another problem peculiar to atomic weapons is the planning of multiple-aiming-point attacks with appropriate intervals in time and space to prevent frequent low-order detonations and/or to assure the safety of friendly aircraft. These procedures are illustrated in Annex 4 of Appendix B.

Number of Atomic Weapons Required for Tactical Use

61. The present study of the Korean Campaign gives some additional information of this controversial subject. Because of the comparative low cost of atomic weapons, and the frequency with which worth-while tactical atomic targets presently occur, the view is rejected that tactical use should be confined to a few atomic weapons reserved for infrequent and especially lucrative targets.

62. In paragraphs 39-40 preceding, it is indicated that in the Korean Campaign, casualties to friendly troops on the defensive would average about 2,400 per atomic weapon and casualties to enemy troops on the offensive would average about 5,000 per weapon (excluding the Taechon example, which seems atypical). Since a defeated enemy will occupy more defensive than offensive positions, it will be assumed that average enemy casualties will be 3,000 per atomic weapon. Half of these will be killed. Experience with conventional weapons suggests that about one-third of the injured will die of wounds or will not return to service for other reasons, including primarily permanent disability, giving 2,000 permanent enemy casualties per atomic weapon expended.

63. In a major war, then, approximately five atomic weapons will be required for direct use against each combat division committed by the enemy, including divisions reorganized from remnant troops. An additional five weapons should be provided per enemy division for use against his logistics,

communications, and supporting services. That is, ten atomic weapons should be provided for each combat division the enemy may be prepared to organize and commit during the course of the war.

64. Against a major military power, who may organize 1,000 divisions during the course of a war, requirements then would be 10,000 atomic weapons. This does not imply the infliction of 10 million permanent casualties by the 5,000 weapons expended directly against his combat divisions.

65. In the first place, many of the weapons will either be smaller than 40 KT or they will be expended against small but important targets. Next, it must be recognized that all weapons, atomic weapons not excluded, are subject to substantial degradation factors from such causes as limited friendly intelligence, enemy countermeasures, and changes in enemy tactics after initial use of the weapons.

66. Neither is it implied that the enemy will be defeated by atomic weapons alone. Atomic weapons must be recognized as powerful, important, and cheap additions to the tactical weapons family but, nevertheless, complimentary to other weapons in that family which will continue to be extensively used against appropriate targets, as explained in Appendix B of this report.

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CONCLUSIONS AND RECOMMENDATIONS

67. These are given in paragraphs 25-43 of the SUMMARY to this report.

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APPENDIX A

ATOMIC WEAPONS EFFECTS ON GROUND FORCE TARGETS

INTRODUCTION

1. a. The military effects of atomic weapons employed tactically are those which ensue from injuries to personnel and damage to equipment. These injuries and this damage depend in turn upon the physical effects of the weapons.

b. Consequently, any estimate of tactical worth must commence with a consideration of the nature and magnitude of the physical effects. This appendix discusses these effects in quantitative and descriptive terms; the tactical significance of the effects described is then developed in Appendix B, following.

c. The discussion of physical effects of atomic weapons in this paper is held to the minimum required for a discussion of the tactical employment of atomic weapons in Korea. For additional technical details, the reader is referred to The Effects of Atomic Weapons, prepared under the direction of the Los Alamos Scientific Laboratory and issued by the Superintendent of Documents, September 1950 (unclassified). A further discussion also will be given in ORO-T-67, Basic Technical Aspects of Atomic Weapons for Army Operations (in preparation).

THE ATOMIC EXPLOSION, GENERAL

Three Principal Forms of Energy

2. a. The effects of the explosion of an atomic weapon are of three types: blast, thermal radiation, and nuclear radiation. These overlap considerably with respect to the damage caused, the numbers of casualties produced, and the total area affected.

b. Blast (and thermal radiation) produce secondary damage and casualties from flying debris, collapsing structures and fires, which frequently transcend any direct or primary results.

c. The thermal radiation intensity resulting from the use of atomic bombs is of a very much higher order of magnitude than that resulting from any conventional weapon, and the primary effect of this radiation also has greater range and duration.

d. Nuclear radiation is a phenomenon peculiar to atomic weapons, not present in any other military weapon.

e. It is frequently possible to maximize any one of the three principal effects by varying the height of burst.

f. In general, approximately 89 percent of the total energy is released at the time of the explosion and 11 percent comes from fission-product radiations delayed in their emission for various times from seconds to years as these fission products decay.*

Energy Release

3. The energy equivalent of a kiloton (1,000 tons) of TNT is 10^{12} calories.* That is, the total instantaneous energy release of a one KT equivalent atomic air burst would be 10^{12} calories, divided approximately as follows:

TABLE I

ENERGY PER EQUIVALENT KT IN AN ATOMIC AIRBURST AT SEA LEVEL

Effect	Percent	Calories per KT
Air blast	53	5.95×10^{11}
Thermal radiation	30	3.37×10^{11}
Gamma radiation	3	$.34 \times 10^{11}$
Neutrons	3	$.34 \times 10^{11}$
Total Initial Energy Release	89	1.0×10^{12}
Delayed (radioactive) Energy	11	0.12×10^{12}

SOURCES OF INFORMATION

4. No atomic-weapon attack has ever been made against a ground-force target. However, the expected damage can be calculated or estimated with reasonable confidence. The principal present sources of applicable data are:

a. Six controlled atomic bomb tests:

(1) Trinity (Alamagordo)

* Effects of Atomic Weapons, pp. 21 and 13, respectively.

(2), (3) Able and Baker (Bikini)
(4), (5), (6) X-Ray, Yoke, and Zebra (Eniwetok)

b. Two atomic attacks on cities:

(1) Hiroshima
(2) Nagasaki

c. Large numbers of field tests with TNT and other conventional explosives.

d. Numerous laboratory tests on the effects of high-intensity thermal and gamma radiation on animals, personnel and materials.

e. Experimental studies in shock tubes on the propagation, diffraction, refraction, and reflection of shock waves in air.

f. Preliminary studies of the US Forest Service on the effects of blast and holocaust fire in natural cover.

5. With the exceptions of items e and f preceding, most of these basic data are given in The Effects of Atomic Weapons. However, many of the data on atomic-weapon effects are inexact or incomplete and further tests remain to be made. Variations in terrain and meteorology complicate the general problem of target-damage prediction. Nevertheless, it now is felt that the radial distance from ground zero corresponding to a given casualty level can be calculated with reasonable confidence for air burst atomic bombs. If the type of cover and the tactical deployment of troops are known or assumed, both the distribution of casualties and the total casualties can be assessed.

THE BASES OF TARGET DAMAGE ESTIMATES

6. Estimates of target damage can be made by the use of graphs and tables giving the degree of expected target damage as a function of distance from ground zero. The principal factors affecting probable damage by an atomic explosion to personnel, structures, materials, and equipment are the following:

a. The TNT energy equivalent of the weapon.

b. Local meteorological conditions at the time of the explosion.

c. The height of the burst.

d. Terrain and major topographical features.

e. Kind and degree of natural and artificial cover.

The principal effects of each of these factors will be discussed briefly in the following paragraphs.

TNT Energy Equivalents

7. The TNT energy equivalents for feasible atomic weapons can range from perhaps 5 to more than 100 KT. In the present paper, a nominal atomic weapon equivalent to 40 KT of TNT generally will be used in estimating the tactical effectiveness of atomic weapons in the present Korean campaign. Each of the principal forms of energy release listed in Table I then would be multiplied by 40, the TNT equivalent of the weapon in KT.

Scaling Laws

8. The scaling laws for atomic weapons permit the effects of sizes other than 40 KT to be estimated readily from the data for 40 KT weapons presented in the present report.

9. Air Blast The peak overpressure, p, is the criterion of blast damage by atomic weapons.

If the overpressure as a function of distances, d_1, is known for an atomic weapon of a given energy, then the overpressure can be determined for another weapon of different energy by scaling all distances, d_2, by the cube root of the ratio of the energies of the two weapons; i.e.,

$$\frac{d_1}{d_2} = \left(\frac{W_1}{W_2}\right)^{1/3} \qquad (1)$$

Thus, if a 40 KT explosion at a height of 3,500 feet produces an overpressure of 8 psi on the ground at a distance of 2,300 yards from ground zero, then a 20 KT explosion at a height of $(20/40)^{1/3}$ x 3,500 feet (about 2,800 feet) also will produce an overpressure of 8 psi at a distance of $(20/40)^{1/3}$ x 2300 yards (about 1,800 yards) from ground zero.

10. Thermal Radiation. a. The criterion of thermal damage by atomic weapons is the total quantity of thermal energy received on a unit area. This energy may be calculated directly from the illumination equation:

$$Q = \frac{Ee^{-\alpha r}}{4\pi r^2} \qquad (2)$$

b. In equation (2), E is the total thermal energy radiated by the ball of fire, $4\pi r^2$ is the total spherical area over which this thermal energy is spread at a distance r from the burst point, and $e^{-\alpha r}$ is an attenuation factor to take account of atmospheric absorption.*

c. It is immediately obvious that if Q is known as a function of r for one atomic weapon of known total thermal energy, then Q can be determined at the same distances r for another weapon of different energy by the scaling law:

$$\frac{Q_1}{Q_2} = \frac{E_1}{E_2} \quad , \qquad (3)$$

provided the same atmospheric conditions are assumed for both cases. For example, if the thermal energy received on a clear day on an area 3000 yards from a 40 KT air burst is 8 calories/cm^2 then a 20 KT weapon would produce 4 calories cm^2 at a distance of 3000 yards on a clear day.

11. Gamma radiation. a. The illumination and scaling laws for gamma radiation are of the same form as equations (2) and (3), preceding, for thermal radiation.

b. Gamma radiation is essentially high energy X-radiation and is characterized by its ability to penetrate considerable thicknesses of massive materials such as earth, concrete, and steel. However, there are no "window" materials (such as air or glass) for gamma radiation and the attenuation coefficient, α, is much higher in air for gamma radiation than for thermal radiation.

c. The biological destructiveness of gamma radiation is measured in terms of the roentgen unit. This unit is more precisely a criterion of the ionizing power of gamma and X-rays, and is measured in terms of the number of ion pairs per cubic centimeter which the radiation produces in passing through a volume of air.

d. Figure 1 gives the gamma radiation dosage in roentgens from a 40 KT atomic air burst as a function of the slant distance in yards from the burst point. It will be noted that to obtain the dosages at any desired distance from the burst point for any other weapon of total energy release

* See paragraph 16

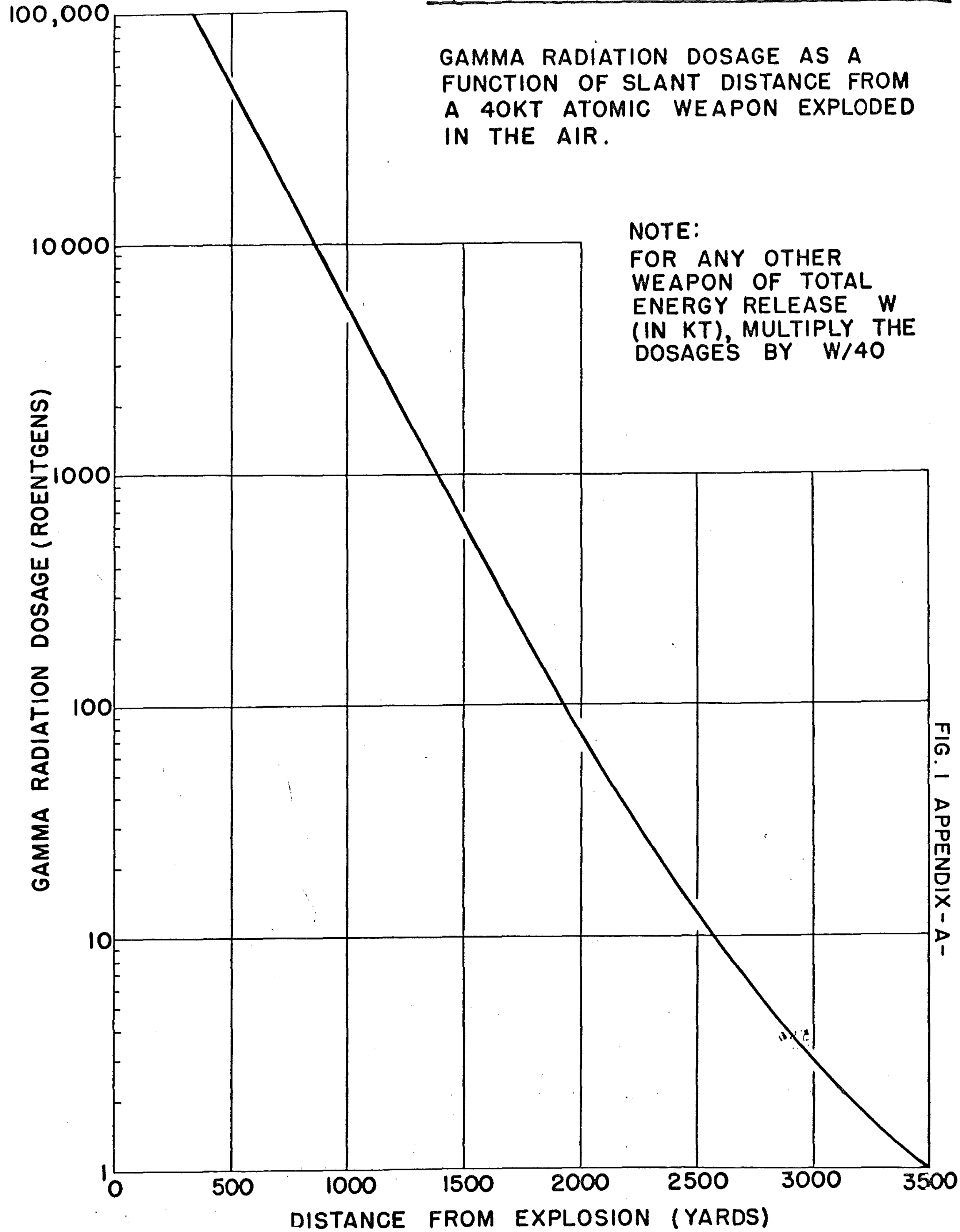

FIG. 1 APPENDIX-A-

W (in KT), it is necessary only to multiply the dosages indicated in Figure 1 by W/40.

12. Neutron radiation. a. The number of neutrons released in an atomic explosion is extremely large. However, they rapidly lose energy by collisions and are heavily attenuated by absorption and capture in all materials so that the neutron intensity falls off very rapidly with increasing distance from the point of explosion. Their lethal range is appreciably less than the lethal range for gamma rays. Neutrons normally present an atomic-explosion hazard to personnel and materials only in a target region already subject to overkilling by blast, thermal energy, and gamma radiation.

b. The small numbers of residual neutrons remaining in the neighborhood during the first minutes immediately following an atomic explosion are of tactical significance, however, since these stray neutrons may cause the next atomic weapon in a series to detonate at less than full energy.*

Meteorological Effects

13. Air blast and gamma radiation. Local meteorological conditions (humidity, temperature, fog, haze, dust, smoke, wind, precipitation) have such slight effects on air blast and gamma radiation that they may be neglected in predicting target damage from these causes.

14. Radioactive contamination. a. In cases of low air bursts (where the ball of fire touches the ground), and on-ground or underground bursts, precipitation and wind speed and direction must be taken into account in estimating radioactive contamination hazards.**

b. For high air bursts, the atomic cloud will rise rapidly toward the base of the stratosphere, carrying with it essentially all of the radioactive contamination in the form of finely divided fission particles and neutron-induced radioactivity from the volume of air surrounding the burst point. The rate of rise of the atomic cloud is so rapid that no harmful gamma radiation from the cloud will reach the ground one minute after a high air burst, (where the ball of fire does not touch the ground; the radius of the ball of fire is approximately ~~600~~ 550 feet for a 40 KT air burst, and proportional to the cube root of the energy release for other TNT equivalents).

In general, the ground area under a high air burst may be entered without danger at the end of one minute except for

* See Appendix B, paragraph 51.
** See paragraph 66 following, for additional details.

such secondary effects as fires ignited in the area and structures on the point of collapse. If it is raining during or immediately after a high air burst, the immediate area downwind from the burst point may receive light to dangerous amounts of contamination from fission particles condensed in raindrops. In the absence of rain, aircraft will be able safely to cross regions under the atomic cloud at altitudes up to 20,000 ft, five minutes after the explosion.*

15. Thermal radiation. The thermal energy radiated by the ball of fire lies in the ultraviolet, visible, and infrared regions. The transmission and absorption of this thermal radiation in the atmosphere follows the illumination law stated in equation (2), paragraph 10. That is, the total thermal energy striking a unit area perpendicular to the direction of the thermal rays will decrease with increasing distance from the ball of fire: (1) by a factor $1/r^2$ due to divergence; (2) by a factor $e^{-\alpha r}$ due to atmospheric absorption and scattering.

16. The attenuation coefficient, α, can be measured in terms of the distance at which large dark objects can be seen against the sky near the horizon. This distance is called the range of visibility and can be related to the attenuation coefficient by the following table, Table II.

TABLE II

VISIBILITY RANGE VS.

ATMOSPHERIC ATTENUATION OF THERMAL RADIATION

Atmospheric Condition	Limits of Visibility (miles)			Attenuation Coefficient	
	(Lower)	(Mean)	(Upper)	per Km	per Yd
Clear	8	12	20	0.2	1.8×10^{-4}
Hazy	4	6	8	0.4	3.7×10^{-4}
Very hazy	1	2.5	4	1.0	9.2×10^{-4}

17. In Figure 2, the total thermal radiation in calories/cm^2 falling on surfaces perpendicular to the thermal rays is given as a function of the slant distance in yards from a 40 KT air burst. The three curves for clear, hazy, and very hazy days refer to the attenuation coefficients given in Table II. It will be noted that, whereas the ranges at which 5 to 10 calories/cm^2 are delivered fall off only about 15 percent for a hazy day, they decrease by about 40 percent for a very hazy day in comparison with a clear day.

* See Appendix B, paragraph 50.

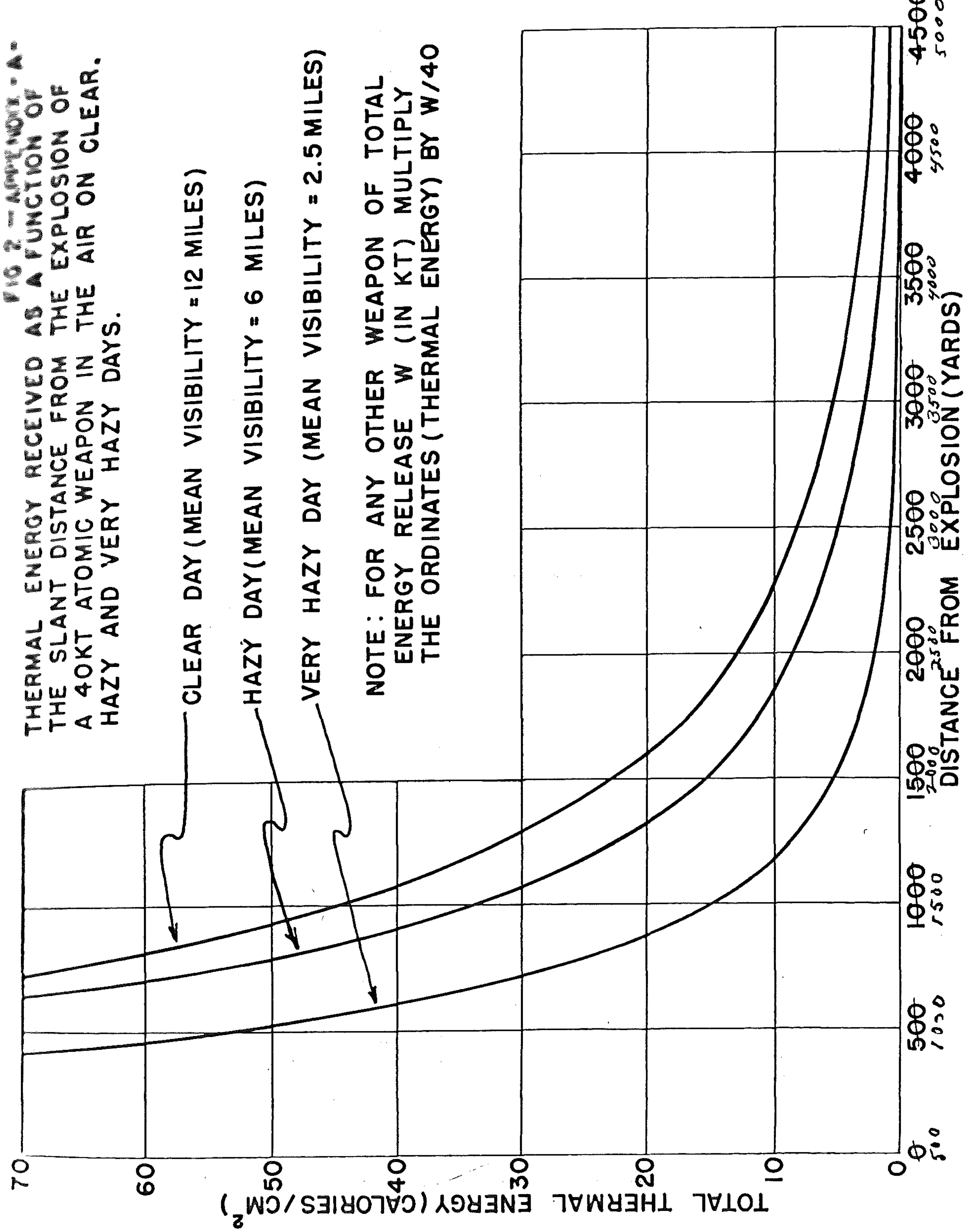

FIG 2 - APPENDIX "A" - THERMAL ENERGY RECEIVED AS A FUNCTION OF THE SLANT DISTANCE FROM THE EXPLOSION OF A 40KT ATOMIC WEAPON IN THE AIR ON CLEAR, HAZY AND VERY HAZY DAYS.

18. Since total thermal radiation energies of 5 to 10 calories/cm^2 produce severe casualties, the importance of thick haze, smoke, fog and rain in reducing troop vulnerability to atomic attack is apparent. However, comparatively thin layers of smoke, haze, or ground fog will not appreciably decrease casualties if the major portion of the thermal-ray path from the burst point to the target lies in a clear atmosphere.

19. Visibility in Korea is affected by fog, dust and haze.* In winter and in late summer, thin radiation fog may form in interior valleys during late night hours and dissipate during the morning. Damp haze due to maritime tropical air masses occurs generally over most of Korea during midsummer and limits visibility to about 6 miles except during afternoon and early evening hours. Airborne dusts from northern Chinese and Mongolian deserts may reduce visibility also during the spring.

20. Figure 3 shows the monthly average visibility at Kimpo Air Base, a few miles west of Kyongsong** (Seoul). It may be noted that visibility shows a cyclic seasonal variation with minima about May-June and December-January, and that the visibility range is consistently highest during afternoon (and early evening) hours throughout the year.

21. If the relative humidity is above about 70 percent, a condensation cloud or "Wilson" cloud will be formed when the air is cooled to below ambient temperature by expansion after the shock front of atomic explosion has passed. Such a cloud will absorb some of the thermal radiation. However, this cloud has limited tactical significance, since it does not develop closer than about 1000 yards from the burst point and occurs too late to absorb more than 15 to 20 percent*** of the total thermal radiation from the ball of fire. The cloud will form if the relative humidity is above about 70 percent, but it will not form at all for relative humidities below about 65 percent.

22. Table III gives the monthly and annual average relative humidities at 12 stations in various parts of Korea. Table IV gives monthly averages of relative humidity by time of day at Wonsan on the Japan Sea and at Inchon on the Yellow Sea. Most of these data are based on 14-year averages.

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* Korea Handbook, Dept. of the Army, G-2, Sept 1950.

** Curves constructed from data in Uniform Summary of Surface Observations, Kimpo, Korea, Oct 1945-Sept 1948; Air Weather Service, USAF.

*** ORO Technical Memorandum on The Wilson Cloud Effect in Atomic Air Bursts, Nov 1950.

APPENDIX A

FIG 3 APPENDIX -A-

KIMPO (KOREA) AIR BASE
MONTHLY AVERAGE VISIBILITY
FOR 6 HOUR PERIODS
(TWO-YEAR SUMMARY)

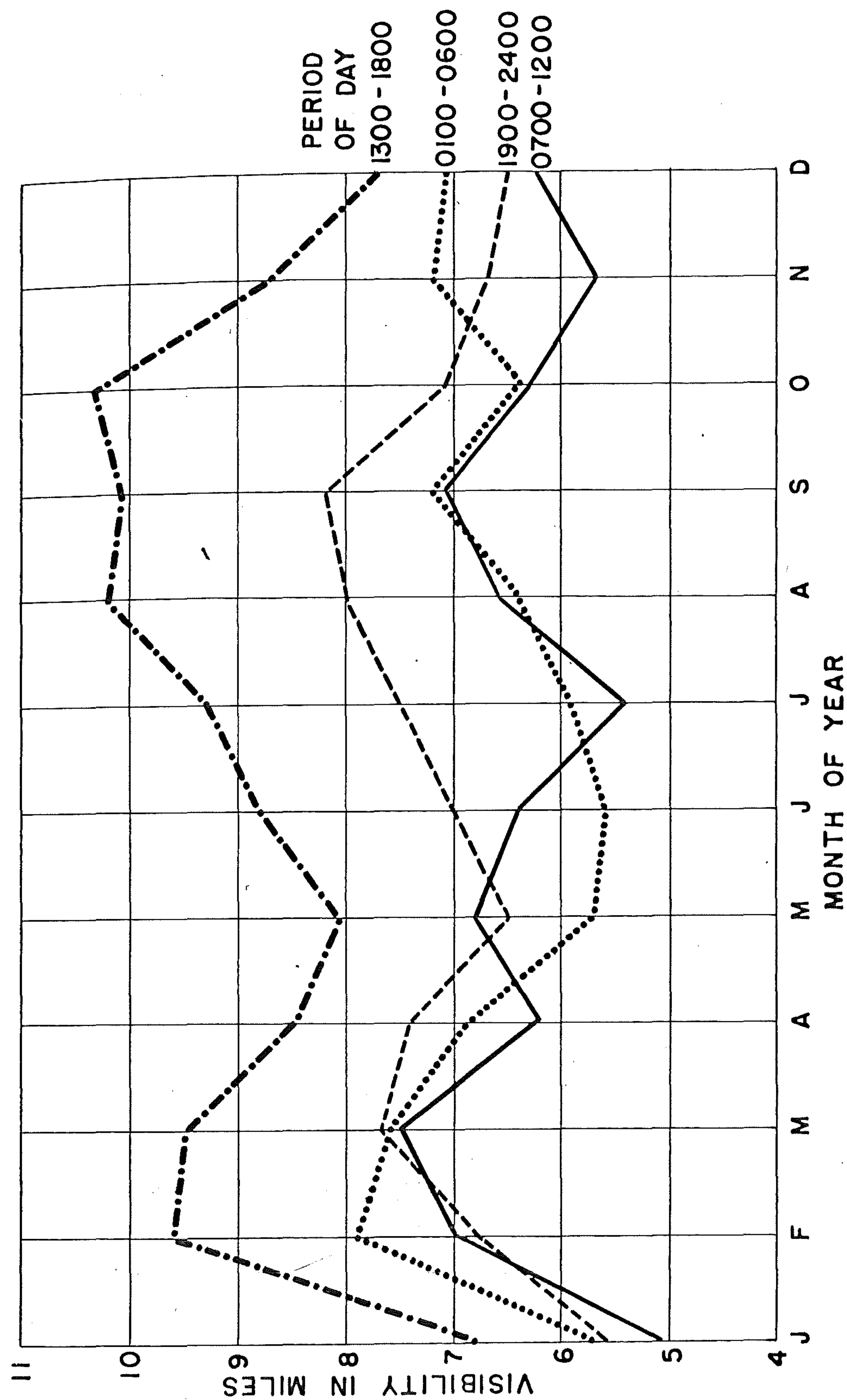


TABLE III

AVERAGE RELATIVE HUMIDITY (IN PERCENT)

BY MONTHS AT KOREAN STATIONS

Station	Location	Annual	J	F	M	A	M	J	J	A	S	O	N	D
Unggi	North, Coastal	65	50	52	55	62	75	83	88	83	71	61	54	49
Wonsan	North, Coastal	66	55	56	58	63	69	75	82	82	75	67	58	51
Kangnung	North, Interior	67	55	60	61	63	69	73	80	81	77	68	60	55
Pusan	South, Coastal	66	51	52	57	67	72	78	83	78	73	65	59	52
Taegu	South, Interior	66	62	60	59	63	64	68	74	74	74	68	67	63
Mokpo	South, Coastal	76	71	70	70	75	77	82	86	82	78	73	72	72
Chonju	North, Interior	75	74	73	70	70	74	73	74	79	78	75	76	77
Inchon	Central, Coastal	71	64	62	65	68	74	76	86	81	72	68	66	66
Kyongsong	Central, Interior	70	68	64	62	65	69	71	80	76	74	71	70	67
Pyongyang	North, Interior	72	71	70	67	64	68	72	81	81	75	72	73	71
Chosan	North, Interior	74	81	76	66	61	64	71	77	80	82	74	77	78
Cheju	South, Island	75	70	71	68	76	76	79	81	82	80	71	70	71

TABLE IV

MONTHLY AVERAGE RELATIVE HUMIDITY (IN PERCENT)

BY TIME OF DAY AT WONSAN AND AT INCHON, KOREA

Station	Time	Annual	J	F	M	A	M	J	J	A	S	O	N	D
Wonsan	0200	72	57	62	61	65	75	88	91	90	84	69	64	66
	0600	74	58	64	63	67	76	88	92	91	86	70	65	63
	1000	64	54	57	53	55	61	75	81	81	71	53	60	58
	1400	57	44	48	47	49	56	71	77	76	64	50	53	51
	1800	63	51	56	53	54	62	75	80	80	72	62	60	58
	2200	70	54	60	59	62	72	86	88	88	81	66	62	62
Inchon	0200	79	70	72	74	77	83	89	92	90	82	75	74	79
	0600	81	72	73	73	78	85	91	93	92	85	77	75	76
	1000	69	65	63	61	63	70	77	83	81	70	64	66	67
	1400	60	56	64	52	55	60	68	75	73	60	52	56	58
	1800	67	63	62	60	62	64	72	77	77	67	63	65	67
	2200	76	68	69	71	74	76	84	89	87	79	71	70	72

Examination of Tables III and IV indicates that in Korea, an air burst would:

a. Usually produce a Wilson cloud for explosions occurring between sunset and sunrise during June, July, August, and September.

b. Frequently produce a Wilson cloud for explosions occurring between sunrise and sunset during June, July, August, and September.

c. Occasionally produce a Wilson cloud for explosions occurring at night between October and May.

d. Rarely produce a Wilson cloud for explosions occurring during daylight between October and May.

23. Meteorological conditions, particularly relative humidity and the amount of sunshine and wind following precipitation, can be of considerable tactical importance, since they govern the ignition and spread of fires in natural and artificial cover after an atomic air burst. The amounts of heat required to ignite thin fuels of various moisture contents are given in Table V. The ignition temperature for these fuels is 340-350° C.

TABLE V

HEAT REQUIRED TO IGNITE LEAF, GRASS, OR STRAW SPECIMEN

0.01 INCH THICK FOR VARIOUS MOISTURE CONTENTS*

Moisture Content in Percent of Dry Fuel Weight	Heat (calories/cm^2)
1	2.4
5	3.0
10	3.5
20	4.5
40	6.3
80	10.1
100	17.3

* Data from US Forest Service

At moderate relative humidities and one to three days after rain, most thin dead fuels and similar combustible materials would be expected to ingite at 3.0 to 4.5 calories/cm^2.

APPENDIX A

EFFECT OF THE BURST HEIGHT ON TARGET DAMAGE

24. The height of burst for an atomic bomb should be chosen in general to maximize the area over which some desired degree or kind of damage is inflicted on the target. Depending upon the nature of the target, the burst height may be chosen to maximize the area damaged by any one of the three forms of energy release (air blast, thermal radiation, gamma radiation). Alternatively, and probably more frequently, the burst height will be chosen so that two or more forms of energy release contribute significantly to destruction of the target.

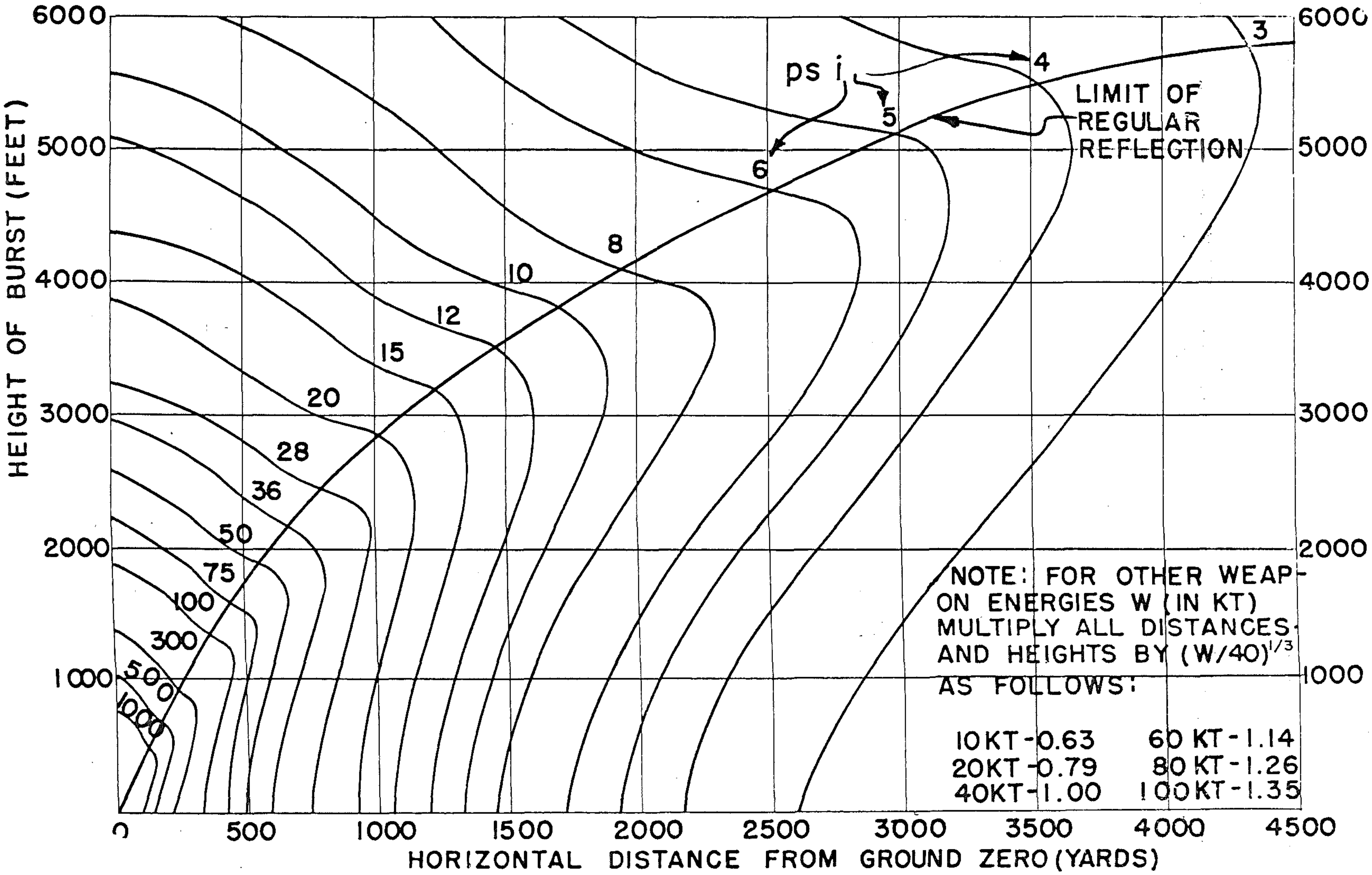
25. Air blast damage. Near ground zero, the incident spherical shock wave and the reflected shock wave intersect on the ground. This condition is called "regular reflection." When the direction of propagation of the incident shock becomes increasingly oblique with the ground, however, a critical angle is reached at which the incident and reflected shocks cease to intersect on the ground; irregular or Mach reflection sets in; the incident and reflected shocks are fuzed to form the Mach stem or Mach wave.

26. The critical angle or limiting angle for regular reflection of shock from a rigid surface depends only upon the strength of the shock. Consequently, for each height of burst there will be a particular distance from ground zero at which irregular reflection begins. Thus, by reference to Figure 4, it will be seen that for a 40 KT air burst at a height of 4100 feet, irregular reflection will begin at about 1900 yards from ground zero and that the resultant fusion of the incident and reflected shock produces a peak overpressure of 8 psi at this distance. However, it also will be seen by reference to Figure 4 that an overpressure of 8 psi can be obtained out to a distance as great as 2300 yards only by lowering the burst height to about 3600 feet. That is, the maximum distance from ground zero for 8 psi (or any other desired overpressure) always is obtained within the region of irregular reflection where a Mach stem exists.

27. It should not be inferred from the discussion in paragraph 26 that the exact height of burst is critical in determining target damage. Consider the following example of target damage by blast overpressures in the neighborhood of 8 psi. Suppose that the burst height lies somewhere between 2500 feet and 4000 feet rather than at the height of 3600 feet mentioned previously. That is, consider the effects of raising the burst to a height about 10 percent greater than 3600 feet and of lowering the burst to a height about 30 percent less. It may be seen from Figure 4 that the following effects can be expected:

FIG. 4 APPENDIX - A -

HEIGHT OF BURST VS. HORIZONTAL DISTANCE FROM GROUND ZERO AS FUNCTIONS OF PEAK PRESSURE FOR A 40KT ATOMIC WEAPON



a. Peak overpressures of 8 psi will be obtained out to at least 2000 yards from ground zero for any burst height within the 2500-4000 feet range. That is, at least 75 percent as much area will be damaged by 8 psi overpressure as in the ideal case.

b. If the burst occurs at a height of 4000 feet, the area covered by 6 psi overpressure will be maximized and will be 1.4 times greater than if the burst had been at a height of 2500 feet. In addition, the overpressure at ground zero would be 18 psi, which is not much smaller than the overpressure of 23 psi obtained from a burst height of 3600 feet.

c. If the burst occurred at a height of 2500 feet, the area covered by an overpressure of 15 psi would be maximized and would be 3 times greater than if the burst had occurred at 4000 feet height. The overpressure at ground zero would be about 50 psi and the areas covered by all overpressures in the range 11 to 50 psi would be significantly larger than for the ideal burst height required to maximize the area covered by an overpressure of 8 psi.

28. Choice of burst height for air blast effects. An extension of arguments of the kind presented in paragraph 27 tends to show that once a blast overpressure had been selected to destroy the more important targets in an area, then the burst height may be chosen at some value lying between the ideal burst height for maximizing the selected overpressure and a burst height about 20 percent lower than the ideal burst height. That is, in the example discussed in paragraph 27, the burst height should lie between about 2900 feet and 3600 feet if the principal targets to be destroyed require overpressures of not more than 8 psi. (A repetition of arguments to show this is left to the reader.)

Thermal Radiation Damage

29. If all targets were erect and on open flat ground, and if no target were shaded by another, then it follows from the illumination law (equation (2), paragraph 10) that the maximum thermal damage would be obtained by lowering the burst height so that the slant distance from the burst point and the horizontal distance from ground zero were substantially equal for all targets. These assumed target conditions obviously are absurd for the majority of ground-force targets. The three more common target conditions, which should be satisfied for maximum thermal damage to army targets, probably are:

a. The selected burst height should tend to minimize the shade afforded to troop and materiel targets by terrain and by natural or artificial cover.

b. The burst height should be selected to maximize the area over which prone or horizontal targets receive damaging amounts of thermal radiation.

c. The burst height should tend to maximize the area over which erect or vertical targets receive damaging amounts of thermal radiation.

30. At least two of the three target conditions stated above are independent and, consequently, can not be met by manipulating a single variable (the burst height). It follows that the proposed solution must be a compromise between the illumination of horizontal and of vertical targets.

31. If the normal to a target surface makes an angle θ with the direction of the incident rays, then the target illumination, q, is given by

$$q = Q \cos\theta ,$$

where Q is the total quantity of thermal radiation which would fall on a unit area oriented perpendicular to the rays. (Lambert's law of illumination)

32. The illumination of a horizontal target surface then would be:

$$q_H = Qh/r = \frac{hEe^{-\alpha r}}{4\pi r^3} \qquad (4)$$

where h is the height of burst and other quantities have the same meaning as in equation (2), paragraph 10.

33. Correspondingly, the illumination of a vertical target surface would be

$$q_V = Qy/r = \frac{yEe^{-\alpha r}}{4\pi r^3} \qquad (5)$$

where y is the horizontal distance to ground zero.

34. It can easily be shown that if the area of thermal damage, over which the illumination of horizontal targets is greater than or equal to q_H, is to be a maximum, then

$$h/r = \frac{1}{\sqrt{3+\alpha r}} \qquad (6)$$

35. In the limiting case of zero atmospheric attenuation ($\alpha = 0$), $h/r = \sin(35.2^\circ)$. In general, αr will not be greater than unity. If αr is unity, $h/r = \sin(30^\circ)$. That is, the total horizontal area covered by a given level of thermal damage will be a maximum provided the burst height is so chosen that when viewed from the periphery of that area the center of the ball of fire will be about 30 to 35 degrees above the horizon. Rolling terrain, ditches, gullies, open entrenchments and foxholes, field-gun and automatic-weapon positions, and the like, rarely provide whole body protection to an angle as high as 30 degrees. Consequently, the first two of the three target requirements stated in paragraph 29 can be satisfied simultaneously by selecting the burst height in accordance with equations (4) and (6).

36. The area of thermal damage over which the illumination of vertical targets is greater than or equal to $\underline{q_V}$ will approach a maximum as the burst height is lowered toward zero. If this condition were met, then thermal illumination against either low or horizontal targets (including crouching, prone, and dug-in troops) would be substantially shaded out by average-to-rough ground and very little direct thermal damage would result. Consequently, thermal damage to vertical targets must be effected by a compromise in the choice of burst height to avoid undue target shade.

37. Various illumination levels for horizontal and for vertical targets, as functions of burst height and distance from ground zero given by equations (4) and (5), are shown in Figure 5, 6, and 7, for clear, hazy and very hazy days respectively. The attenuation coefficients used in constructing the illumination curves have been given in Table II.

38. Choice of burst heights for thermal effects. It usually is possible to choose an optimum burst height which will tend to maximize thermal damage to both horizontal and vertical targets. For example, suppose that the thermal-destruction level desired is 10 calories/cm^2 and that the day is clear. By equations (4) and (6) it can be computed that a burst height of 3500 feet would give a maximum target radius from ground zero of 1825 yards for an illumination of 10 calories/cm^2 against prone targets, and that the altitude of the center of the ball of fire above the horizon 1825 yards from ground zero would be 33 degrees. However, by reference to Figure 5, it may be seen that an exact choice of burst height is unnecessary since the target radius would be at least 1800 yards for *any* burst height between 2500 feet and 4000 feet. It also may be noted that if the burst height is 2500 feet, then vertical targets will be illuminated with 10 calories/cm^2 to a distance of

2500 yards, provided the angle of shade from the ball of fire for vertical targets is not greater than about 18 degrees above the horizon.* On the other hand, if the burst height is 4000 feet, the vertical target illumination distance for 10 calories/cm^2 will be reduced to about 2250 yards, but a shade angle of about 30 degrees would be required to protect a vertical target.

39. Suppose now that in the example under discussion there are also targets in the area which will be thermally damaged by 5 calories/cm^2. If the burst height is 4000 feet, Figure 5 indicates for 5 calories/cm^2 a damage distance of 2400 yards and a shade angle of 29 degrees for horizontal targets, while the damage distance is 3200 yards and the shade angle about 22 degrees for vertical targets. By contrast, if the burst height is 2500 feet, the damage distance will be reduced to 2250 yards and the shade angle to 20 degrees for horizontal targets, while the damage distance will be 3400 yards and the shade angle only about 14 degrees for vertical targets. In this case, then, many of the more distant targets might escape damage for the 2500-foot burst height because of the comparatively low shade angles required to protect them from thermal radiation.

40. It may be concluded from the above discussion and from an examination of Figures 5, 6, and 7 that the choice of burst height for thermal damage will be determined in part by the kinds, relative numbers, and importance of horizontal and vertical targets in the area, and in part by the shade angles afforded these targets by terrain and cover. In general, a variation of plus or minus 10 percent in the burst height will cause little significant change in thermal damage to targets.

Gamma Radiation Damage

41. Gamma-ray intensities in roentgens are shown in Figure 8 as functions of the burst height and the distance from ground zero. It will be noted that at distances of the order of 1500 yards from a 40 KT air burst the gamma ray intensities decrease by a factor of two for each increase of about 500 feet in distance from the burst point.

Radiation sickness begins with whole body dosages of about 100 roentgens, and dosages above 700 roentgens produce

* The shade angle is the same as the altitude angle (measured from the horizon) of the center of the ball of fire; i.e., if the shade angle is small, objects cast long shadows. Since the ball of fire for a 40 KT burst is roughly 1100 feet in diameter, these shadows will not have sharp boundaries.

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FIG. 5 APPENDIX -A-

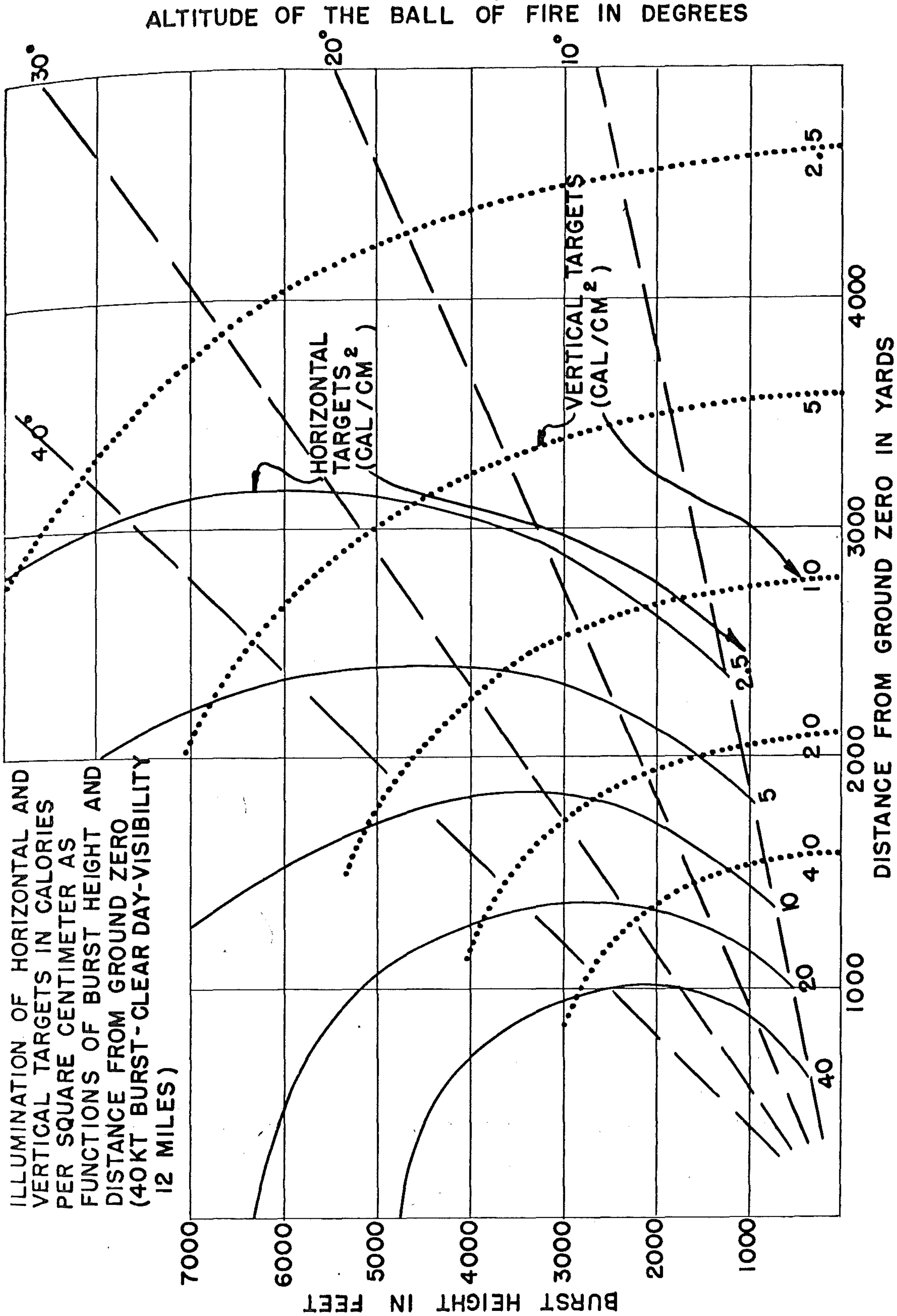
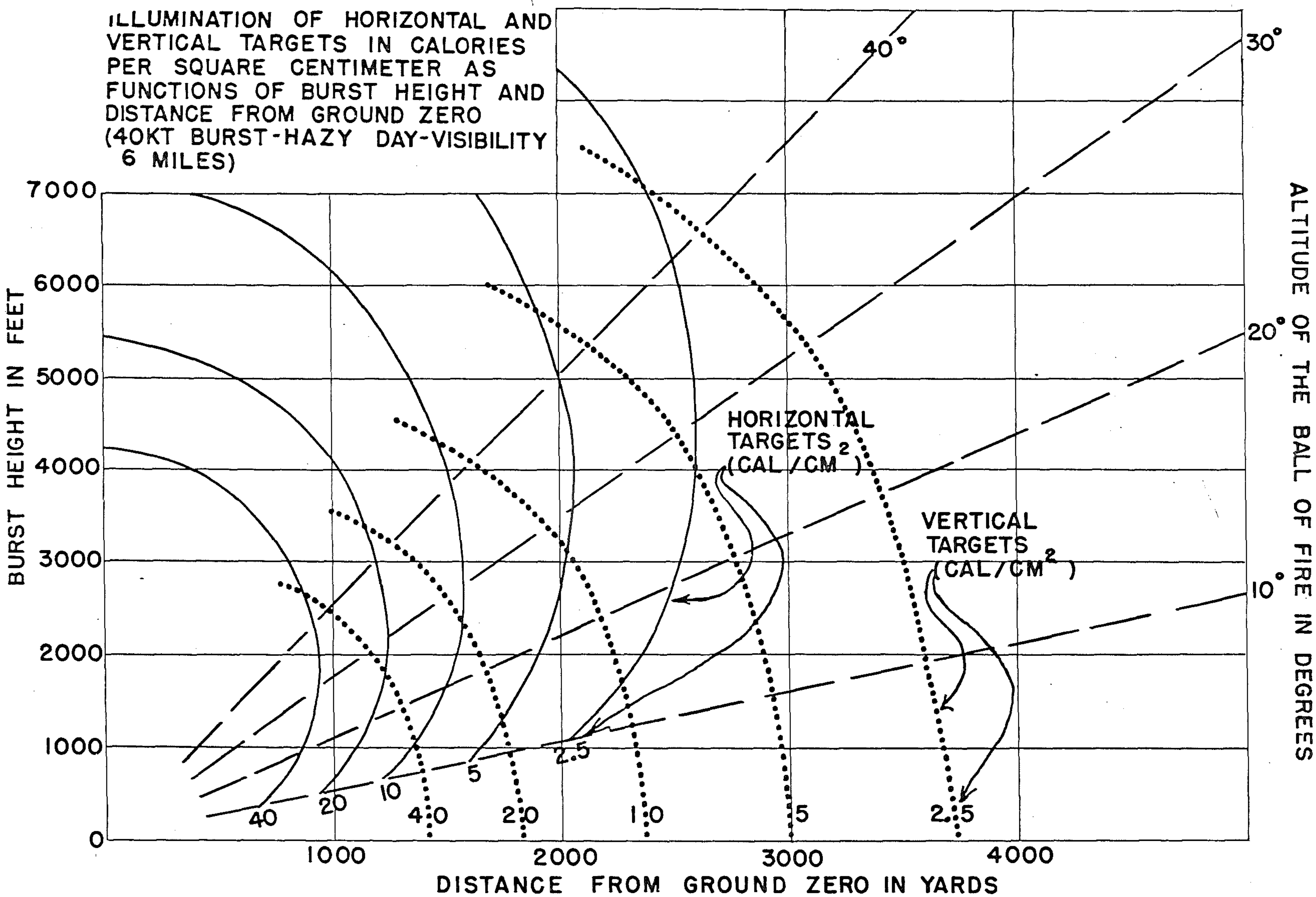


FIG. 6 APPENDIX -A-

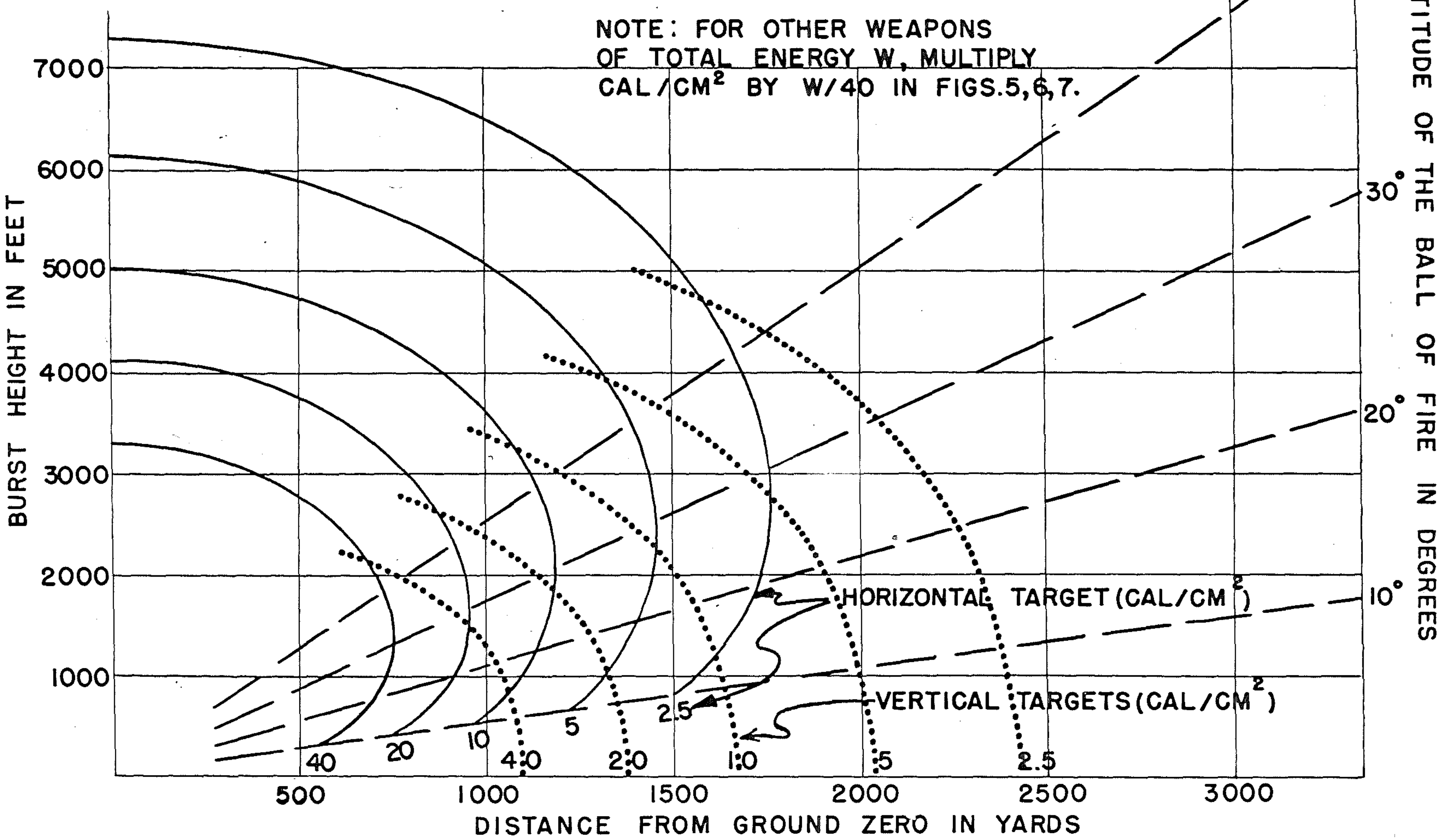


ILLUMINATION OF HORIZONTAL AND VERTICAL TARGETS IN CALORIES PER SQUARE CENTIMETER AS FUNCTIONS OF BURST HEIGHT AND DISTANCE FROM GROUND ZERO (40KT BURST-HAZY DAY-VISIBILITY 6 MILES)

FIG. 7 APPENDIX - A -

ILLUMINATION OF HORIZONTAL AND VERTICAL TARGETS IN CALORIES PER SQUARE CENTIMETERS AS FUNCTIONS OF BURST HEIGHT AND DISTANCE FROM GROUND ZERO.
(40 KT BURST — VERY HAZY DAY — VISIBILITY 2.5 MILES)

NOTE: FOR OTHER WEAPONS OF TOTAL ENERGY W, MULTIPLY CAL/CM² BY W/40 IN FIGS. 5, 6, 7.



essentially 100 percent deaths. Consequently, nonfatal gamma-radiation casualties among troops generally will occur only in a narrow ring of about 500 yards width.

42. Since gamma rays penetrate considerable thicknesses of massive materials, there is no direct analogy with shade from thermal radiation unless the interposed materials are several inches in thickness. Although tables of gamma ray dosages required to produce casualties usually are given in terms of exposure of the whole body, it is well known that the greater damage is done to such middle and lower regions of the body as the spleen and leg-bone marrow, while the head, shoulders, and chest are markedly less vulnerable. For this reason, considerable gamma ray protection is afforded to troops by terrain or by entrenchment if the altitude angle of the ball of fire is 30 degrees or less. In a general way, then, the solid line curves shown in Figure 8 are applicable only to erect targets on flat ground unless the altitude angle is high.

43. There are important army targets which have massive protection on the sides and only thin cover overhead. Most dug-in positions fall in this category. Likewise, tanks have side and frontal armor several inches in thickness, but the top armor is only about an inch thick. For personnel with this type of protection, the incident gamma radiation per unit area of horizontal surface is probably a better criterion of damage than the radiation per unit area normal to the direction of the rays. The dotted curve in Figure 8 shows the relation between ground distance and burst height required to give a gamma-ray flux of 400 roentgens through unit horizontal area. Similar curves for the other gamma-ray dosage-levels shown could be constructed by decreasing the radial distance from the origin to a given dosage level, by the radial distance between the dotted curve and the solid 400r dosage curve for each altitude angle. It may also be noted that for altitude angles of 30 degrees or more, the spread between the effective distances from ground zero indicated by the dotted curves and the distances indicated by tl ... given gamma-ray dosage is less than

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P. 52, paragraph 43 - Add "For example, suppose a curve, representing a gamma-ray flux of 100 roentgens through unit horizontal area, constructed by reference to the difference between the solid and dotted curve for 400 roentgens in Figure 8. It is indicated that for altitudes of near 30° a minimum gamma-ray dosage of 100 roentgens would be delivered against troops in a target area of about 1500 yards radius if the height of a 40 KT burst was 2500 to 3000 feet."

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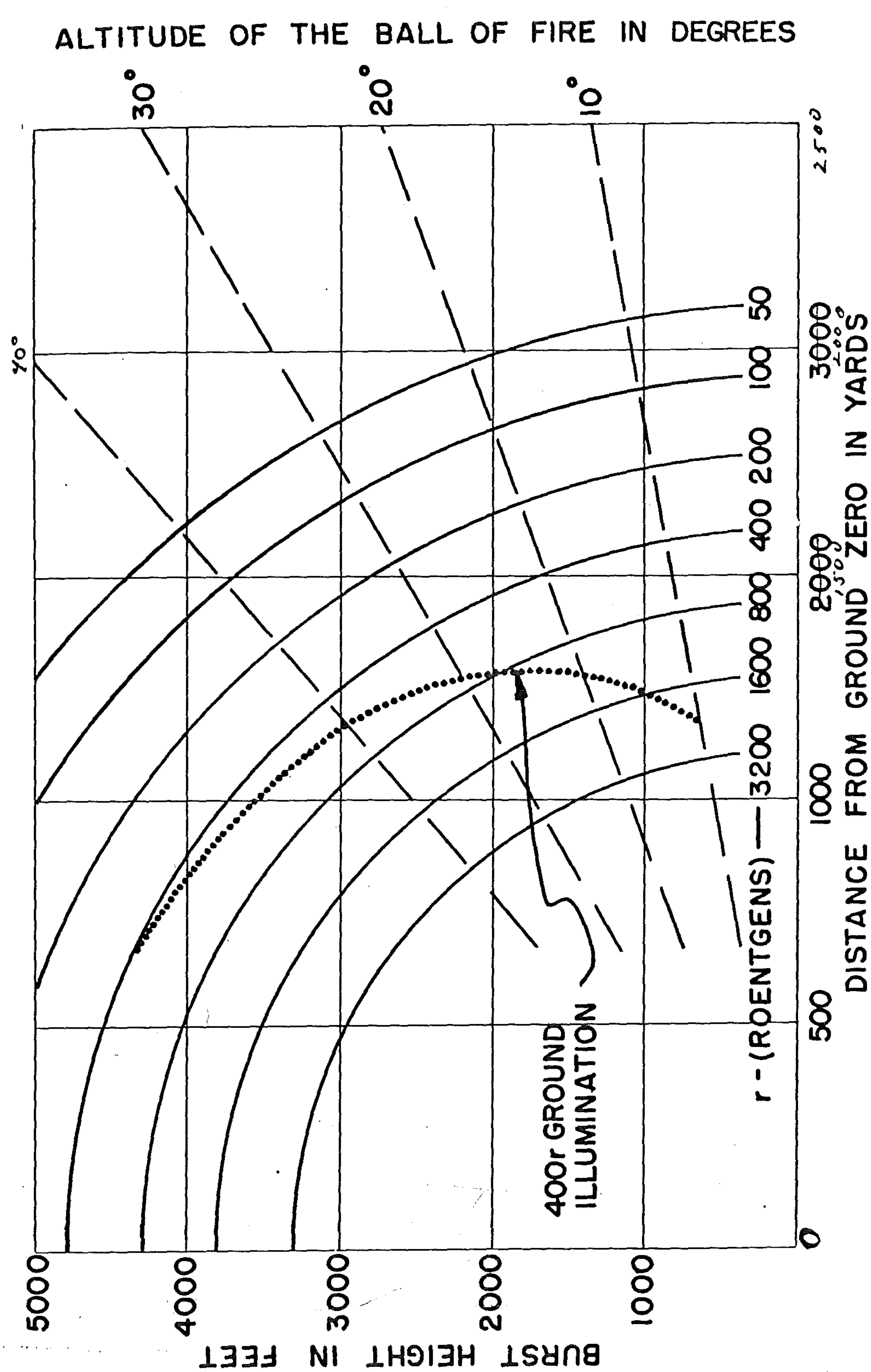
FIG. 8 APPENDIX -A-

GAMMA RAY INTENSITIES IN ROENTGENS AS FUNCTIONS OF BURST HEIGHT AND DISTANCE FROM GROUND ZERO (40KT BURST—FOR OTHER ENERGIES, MULTIPLY ROENTGENS BY W/40)



~~indicated thay a minimum gamma-ray dosage of 100 roentgens would be delivered against troops in a target area of about 1500 yards radius if the height of a 40 KT burst was 2500 to 3000 feet.~~

Choice of Burst Heights for Combinations of Effects

45. The preceding discussion has indicated that the burst heights of an atomic weapon can be chosen to maximize the target area affected by a selected level of blast overpressure, thermal radiation, or gamma-ray dosage. It also has been seen that when the affected area approaches its maximum size, a variation of 10 percent or more in the burst height will not appreciably change the size of the affected area. This latitude in the choice of burst height for a given weapon effect will frequently make it possible to choose an optimum burst height which will tend to maximize the area damaged by the combined effects of air blast, thermal radiation, and possibly gamma radiation. A hypothetical example will be given below for illustration.

46. Suppose that a troop concentration in an area of low hills is partly dug in, partly bivouacked in Korean village huts, partly encamped in lightly wooded patches, and partly employed in the open. Further, suppose that the blast overpressures required for blowdown are 7 psi for trees and 4 psi for Korean huts; that 10 to 12 calories/cm^2 will char or ignite uniforms, and 5 calories/cm^2 will produce incapacitating skin burns; and that the minimum gamma ray dosage required to produce an appreciable amount of radiation sickness is 200 roentgens. What burst height should be chosen for a 40 KT weapon on a hazy day when the visibility is about 6 miles?

47. First, consider air blast overpressures. By reference to Figure 4, it may be seen that near their maxima, the radii of damage for overpressures of 7 psi will range from 2350 to 2500 yards for burst heights of 3000 to 4000 feet. At burst heights of 4000 feet, 3500, and 3000 feet, the corresponding 4 psi damage radii will be 3450, 3250, and 3100 yards respectively. If the burst height were raised to 4500 feet in order to increase the 4 psi damage radius to 3600 yards, then the 7 psi damage radius would decrease to 2000 yards. Consequently, a burst height of 3000 to 4000 feet is indicated, since both the 7 psi and the 4 psi damage radii will be satisfactorily large for this range of burst heights.

48. Next, consider thermal damage. The troops are among low hills and partly dug in. Consequently, the angular altitude of the ball of fire should be 25 to 35 degrees in

the 5 to 10 calories/cm^2 damage range in order to minimize protective shade by terrain or entrenchment. By reference to Figure 6 for a hazy day, it may be seen that this shade condition will be met for burst heights of 3500 feet or more for both horizontal and erect targets at illuminations of 5 to 10 calories/cm^2. However, if the burst height were as high as 4000 feet, the 10 calories/cm^2 illumination of vertical targets would reach to appreciably less distance than for a 3500 foot burst height. Furthermore, a burst height of 3500 feet would give approximately maximum coverage of horizontal targets at illuminations of 5 to 10 calories/cm^2. In the preceding paragraph, a burst height of 3500 feet also has been seen to be satisfactory for target coverage with blast overpressures of 4 to 7 psi. Consequently, a burst height of about 3500 feet represents an optimum choice, tending to maximize the target area receiving blast and thermal damage simultaneously under the conditions assumed in the problem.

49. Finally, consider gamma-radiation dosages delivered against the above hypothetical target. Figure 8 indicates that 200 roentgens would be received at 1250 yards from ground zero for a burst height of 3500 feet and that lowering the burst height would increase the radius toward 1500 yards. However, the loss in target area damaged by blast and thermal radiation would be greater than the gain in targets damaged by gamma radiation if the burst height were lowered. Furthermore, under the conditions assumed in the problem, air blast and thermal radiation are sufficient to overkill the target in the region affected by gamma radiation. Consequently, no further compromises in burst height are required in order to increase the effectiveness of the weapon, so the indicated burst height remains at about 3500 feet and the principal target damage would be caused by air blast and thermal radiation.

EFFECTS OF TERRAIN AND TOPOGRAPHY

50. The effects of terrain, particularly with respect to the reflection and diffraction of air blast, are complex and only the more gross effects will be considered here.

51. Scale of topography. Since distances for air-blast effects scale as the cube root of the energy release*, multiples of about 430 feet for a 40 KT explosion can be considered equivalent to multiples of one foot for a one-pound TNT explosion. On this basis of comparison, a hill 860 feet high would have effects on a 40 KT explosion comparable with the effects of a two-foot mound on a one-pound explosion.

* Paragraph 9.

(On the same scale, a six-foot man would appear about 1/6 inch tall.) In other words, distances and heights of the order of 500 to 1000 feet present reasonably minor topographical features to a 40 KT explosion.

Minor to Rough Topography

52. Effect on air blast. a. Low hills and ridges, embankments, and revetments offer comparatively little protection against primary blast damage since their dimensions are small in the scale of the blast-damage distance for a 40 KT explosion. Furthermore, localized reflections and diffractions of the shock front tend to increase the blast damage. For example, aircraft parked in revetments will be caught and buffeted by reflected and diffracted shock waves with resultant damage equaling or exceeding that received in the open. In a similar way, experience at Hiroshima and Nagasaki and experiments with shock tubes indicate that one building will not effectively shield another nearby building from blast.

b. On the other hand, a shallow ditch or low embankment may be used as shelter against secondary blast damage since blast-blown debris may carry over these obstacles without striking objects behind them.

53. Effect on thermal shade. Any opaque shield will provide shade against thermal radiation from the ball of fire. However, the following effects tend to minimize the effectiveness of shade for troops in the field:

a. The burst height can be chosen so that within the area of heavy thermal damage (5 calories/cm^2 or more) the angular altitude of the ball of fire will be higher than 25 degrees*. Consequently, minor terrain features will not provide effective shade from the ball of fire.

b. At distances of 1250 yards and less from ground zero, nominal opaque shade will be penetrated by heavy gamma ray dosages**.

c. Near sea level the volume of the ball of fire is proportional to the total energy release, and its diameter will be about 1100 feet for a 40 KT air burst. Consequently, objects will not cast shadows with sharp boundaries and only a part of the ball of fire may be obscured by intervening objects.

d. Illuminated areas in the neighborhood of an air

* See paragraphs 29-40.
** See paragraphs 41-44.

burst reflect or scatter thermal radiation into areas wholly or partially shaded from direct radiation. This effect will be more pronounced if the ground is snow covered. Characteristic values of the albedo or diffuse reflection for some ground materials are, roughly: 15 to 20 percent for sandstone and coarse gravels; 25 percent for sandy loams; and 40 percent for yellow sands and buff-colored soils.

Major Topographical Features.

54. Mountains and high hills can appreciably alter the area of damage by atomic weapons unless they are taken into account in the choice of aiming points. For example, a high steep slope may prevent Mach reflection toward the crest* so that blast damage near and over the crest will be light (as was observed at Nagasaki where the bomb was exploded over a valley). On the other hand, blast up and down a valley will tend to be channelized and so extend to somewhat greater distances than on flat ground. Damage in blind valleys also may be intensified by the diffraction and reflection of blast. In other words, in mountain and valley situations, major blast damage from an air burst over the valley will tend to be confined to the valley and near slopes.

55. In contrast with air blast, the effect of terrain on thermal radiation is simple. The radiation is propagated in straight lines and the areas which will be shaded by terrain can be picked out on a relief map or identified by constructing profile cross-sections of the terrain near the aiming point as discussed in paragraphs 57-60.

56. A further feature in mountainous terrain is that the valleys between major crests and ridges usually are several times wider than the heights of their surroundings, since long-sustained slopes averaging as much as 20 degrees (35 percent grades) are very rare. That is, mountain valleys dominated by major heights generally will present target widths comparable with or exceeding the damage diameter of a single atomic explosion.

Aiming Point Selection to Minimize Terrain Effects

57. The approximate effects of terrain can be taken into account, if necessary, in the selection of aiming points. This is readily done for the large-scale effects of atomic weapons by laying out the damage circles and the heights of burst to scale in three dimensions, provided a relief map of the area is available. The six aiming points selected for the hypothetical defense with atomic weapons of Line Baker

* See paragraphs 25-26

north of Seoul against the CCF attack of 31 December 1950* will serve as an illustration. Pins of lengths representing the burst heights, and thin transparent plastic discs representing the target damage circles, were placed on a plastic relief map of the area as shown in the photograph of Figure 9. (These relief maps are transverse Mercator projections, horizontal scale 1:250,000, vertical scale 1:83,333; i.e., the vertical exaggeration is 3:1.) A similar target circle layout covering the Pyonggang-Kumhwa-Chorwon troop assembly triangle** is shown in Figure 10. In both of these cases the use of relief maps showed that the shading of targets from thermal radiation by terrain was negligible, and that the shielding or focusing of air blast by terrain also was small.

58. An alternate method of estimating terrain effects by constructing terrain-profile diagrams may be illustrated by the two most easterly of the six aiming points selected for the hypothetical defense of Line Baker. These examples also illustrate the minor effect of rolling-to-rough Korean terrain on atomic weapon damage.

59. As an example of rolling ground, Figures 11 and 12 show the N-S and E-W profiles through the aiming point at CT310140, drawn to scale for horizontal and vertical distances and diameter of the ball of fire. It is apparent from the diagram that this terrain would not shade any troops from illumination by the ball of fire within an effective thermal-damage distance of about 4 kilometers. The approximate distances for the onset of Mach reflection for air blast are designated by M in these figures and indicate that shielding or focusing of the shock wave by terrain irregularities would not reduce the area of primary and secondary blast damage.

60. As an example of rough terrain, Figures 13 and 14 show N-S and E-W profiles through the aiming point at CT403125, one kilometer north of the crest of Hill 555 (altitude 555 meters). Here again it may be noted that only a small region north of ground zero would be shaded from thermal radiation and that shielding from or focusing of the blast wave also would have comparatively minor effect on total damage.

61. Finally, it should be noted that the primary topographical features of a region (rivers, commanding heights, ridge or valley routes, etcetera) in themselves tend to control the bivouac, assembly, tactical deployment, and battle movement of troops. Consequently, the effects of terrain on

* See Annex 1, Appendix C.
** See Annex 4, Appendix B.

APPENDIX A

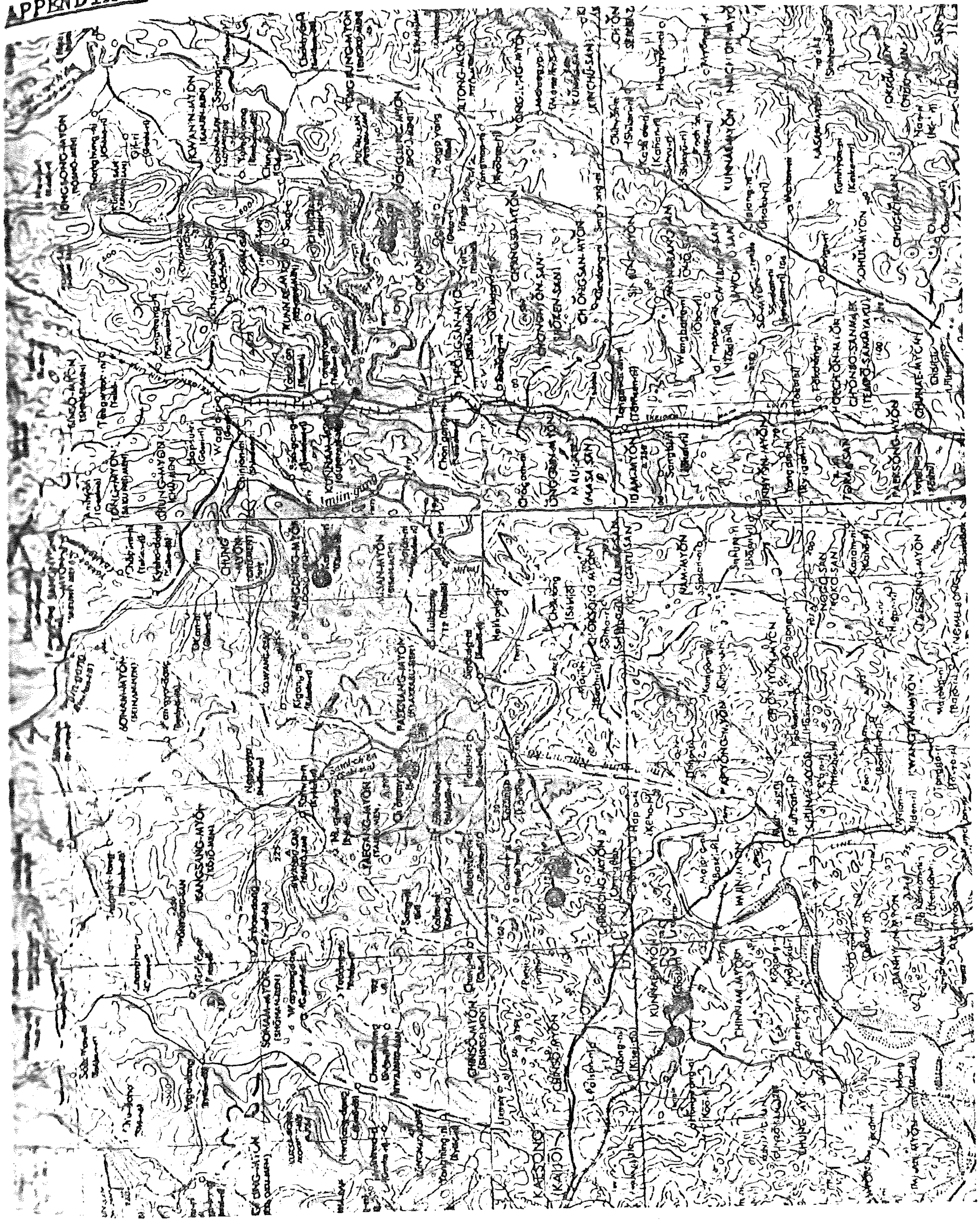


Figure 9.--Terrain relief map and aiming point pattern, line Baker, Imjin River.

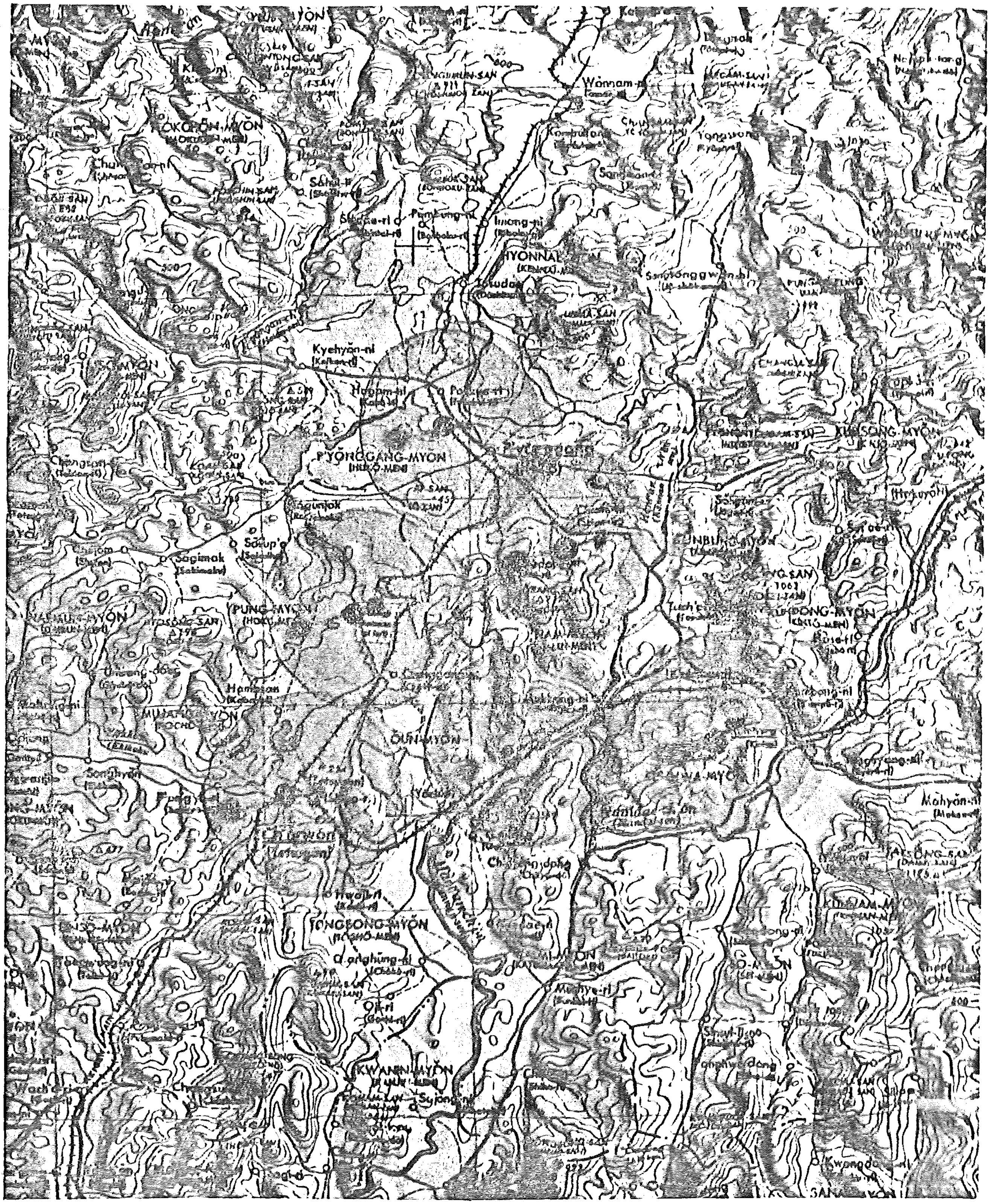


Figure 10.--Terrain relief map and aiming point pattern, Pyonggang-Kumhwa-Chorwon triangle.

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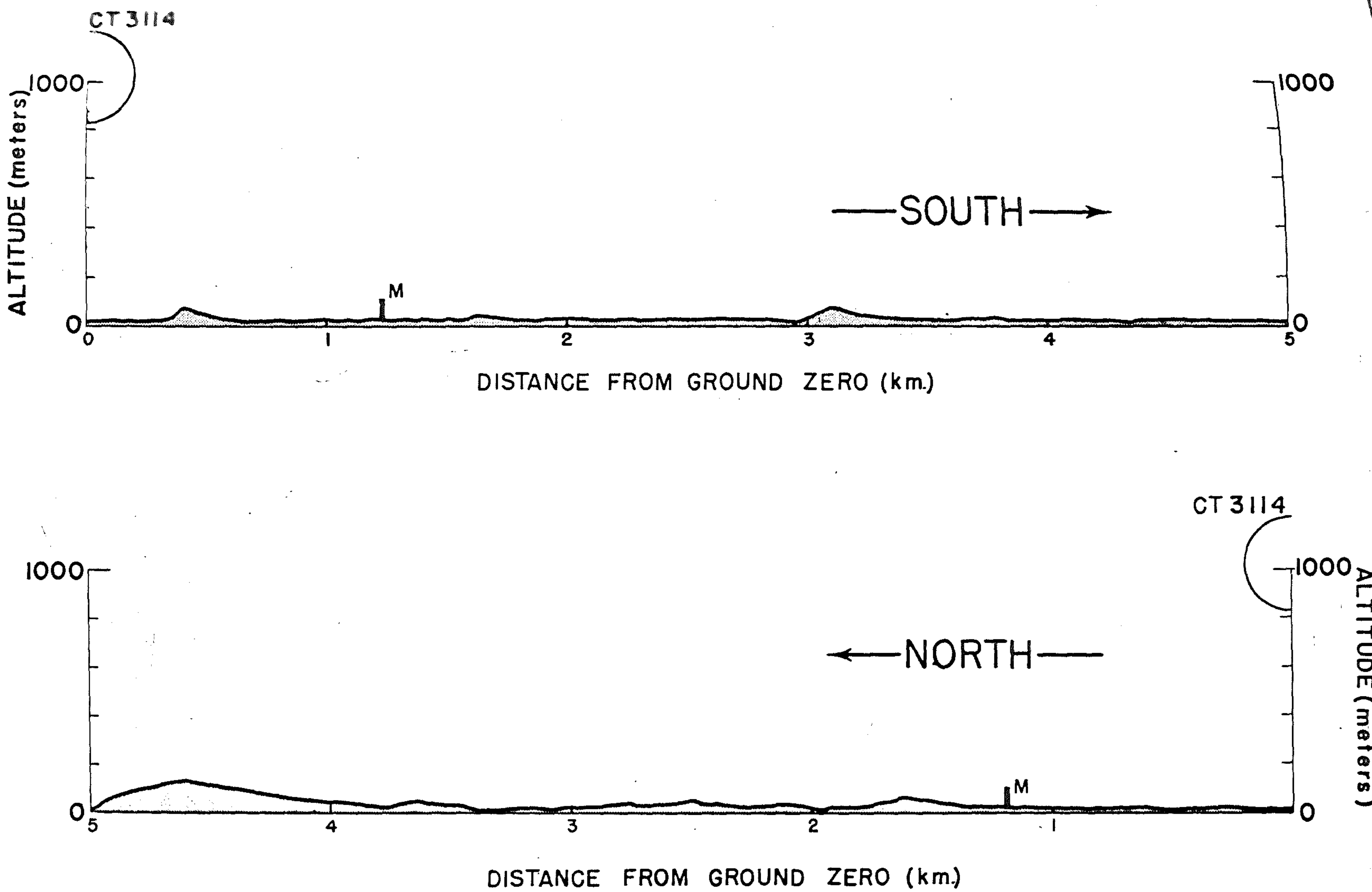
FIG 11 APPENDIX-A-



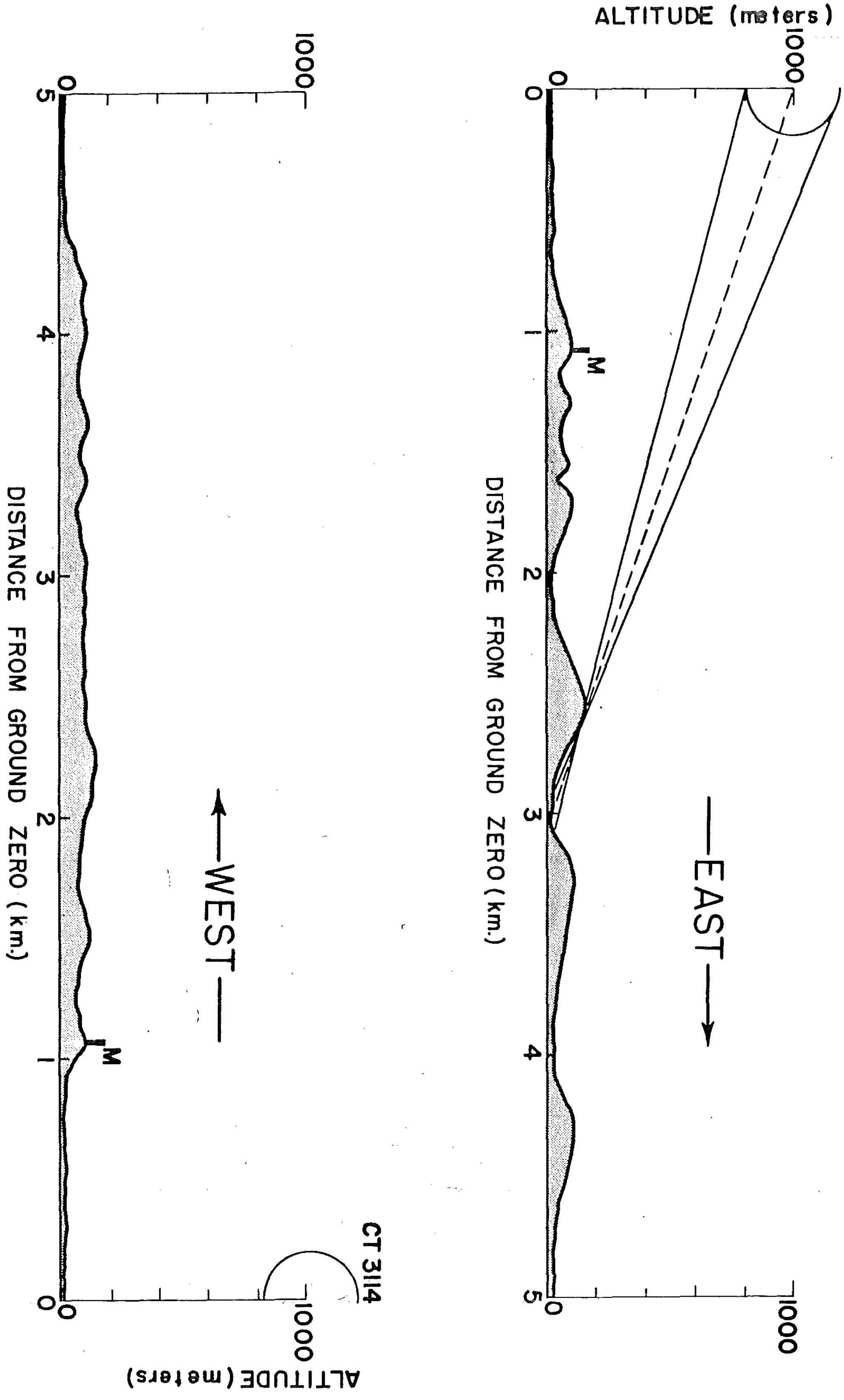


FIG. 12 APPENDIX -A-

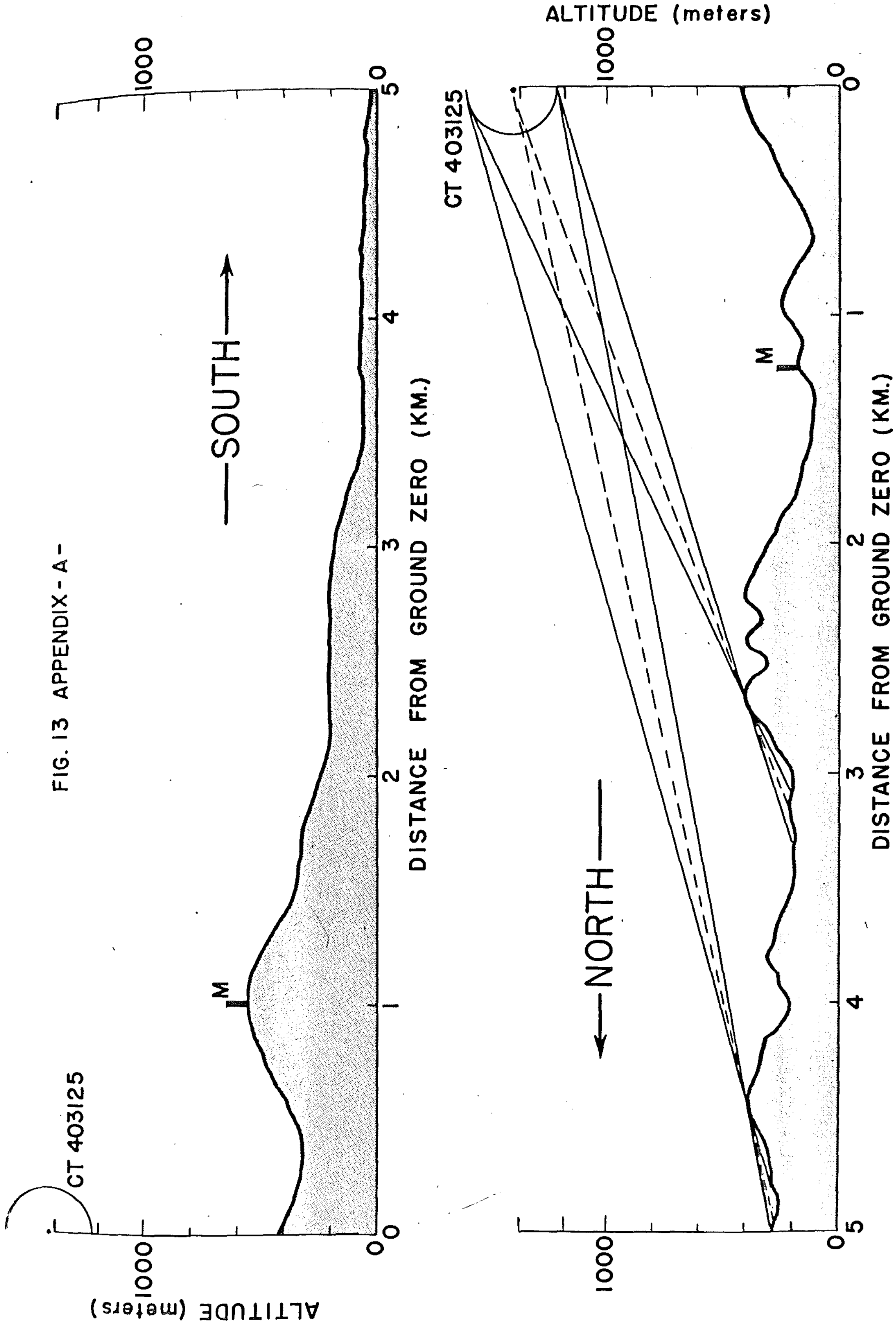


FIG. 13 APPENDIX-A-

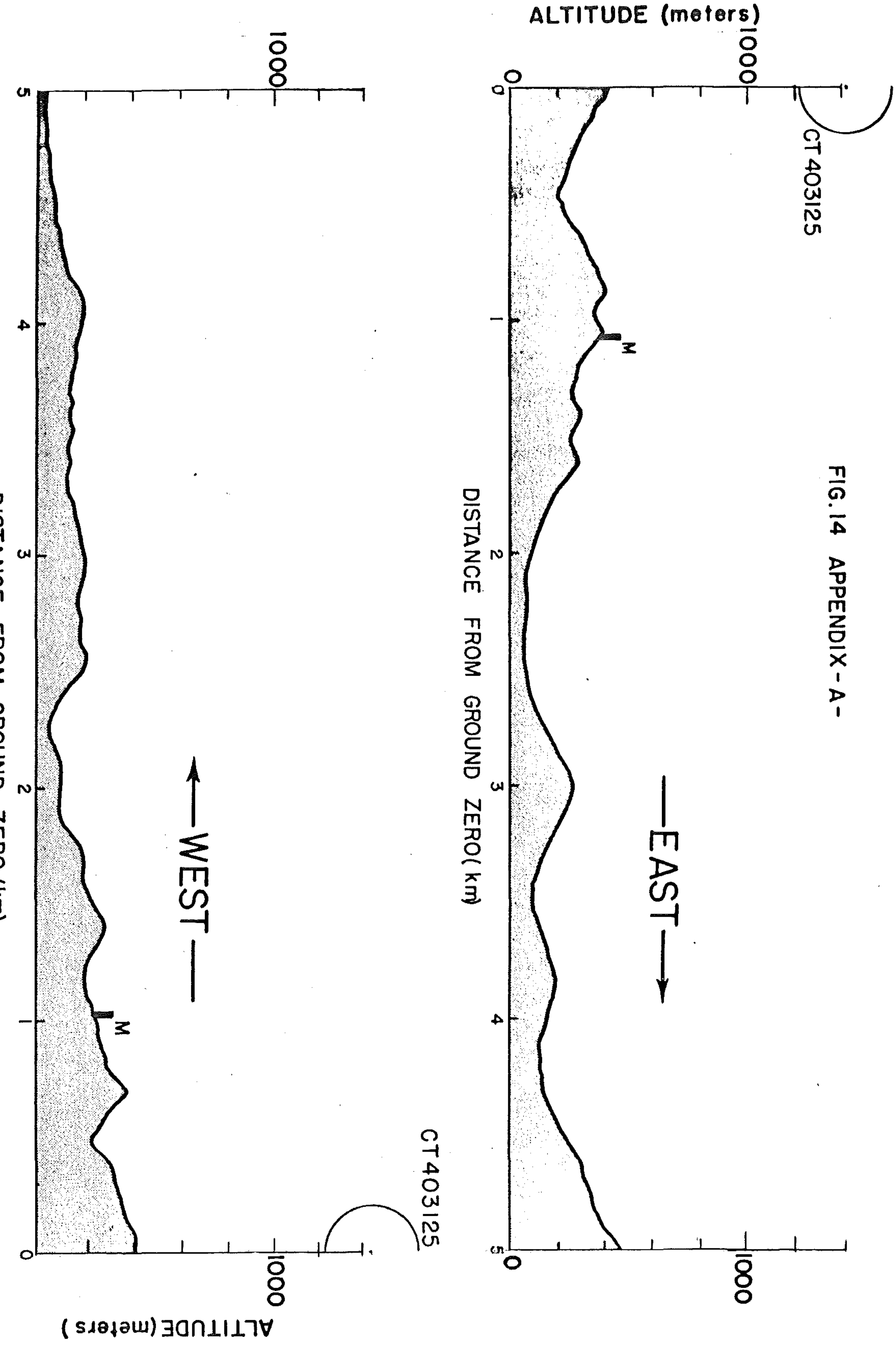


FIG. 14 APPENDIX-A-

the disposition of targets as well as the effects of terrain on target damage, should be taken into account in the selection of the more desirable aiming points and heights of burst in planning an atomic attack against ground-force targets. In fact, the effect of terrain in controlling the distribution of targets is likely to be more important than the effect of terrain in modifying atomic air blast and thermal radiation damage to these targets.

SURFACE AND SUBSURFACE BURSTS

62. Hard targets. Most ground-force targets are relatively soft in the sense that they can be attacked effectively by air burst atomic weapons. A less frequent but important group of ground-force targets, such as airfield runways, low, reinforced or subterranean fortifications, main supply routes through defiles, and dug-in command posts, are "hard" targets resistant to damage by air blast and thermal radiation. These targets may be destroyed by ground cratering, earth shock, avalanche or talus falls, or radioactive contamination produced by on-ground or underground atomic bursts.

63. Cratering. No full-scale test of an on-ground or underground atomic burst has yet been held and present estimates must be based on small-scale TNT tests supplemented by conjecture based on the Bikini Baker atomic burst under water. Estimates of the diameters of craters for various underground burst depths are given in Table VI for a 20 KT TNT-equivalent explosion.

TABLE VI

EXPECTED CRATERING IN FLAT GROUND* 20 KT EXPLOSION

Depth of Explosion (Feet)	Crater Diameter (Feet)	Throw-out (in Millions of Cubic Yards)
-100 (above ground)	Superficial depression	Radioactive dust only
0 (on ground)	700**	0.4
20	800**	0.7
40	910	1.0
60	1,020	1.5
100	1,230	2.7
200	1,640	6.5
500	2,250	20.0

* Wet clay overburden assumed; however, cratering is nearly independent of the type of overburden.

** Diameter and throw-out values are uncertain for depths less than 40 feet, reasonably dependable for greater depths.

64. Blast and thermal damage by underground bursts. A 20 KT atomic burst at a depth of 50 feet gives an extremely shallow explosion since, in scale, it corresponds to the explosion of a 100-pound spherical TNT charge with its center only 8 inches below the surface. That is, the resultant air-blast energy will not be much less than for an air burst. However, no Mach stem will form and the total area of air-blast damage will be appreciably smaller. Thermal radiation from the ball of fire, on the other hand, will be largely obscured by the dust and ground debris thrown out of the crater.

65. Ground roll. a. The ground shock in the immediate neighborhood of the crater will reach earthquake proportions, with both horizontal and vertical displacements present in the ground roll. These displacements will exceed 100 feet near the crater lip and decrease at a rate lying between the inverse square and the inverse cube of the distance from the explosion center, so that the displacements at, say, 3,000 feet from center, will be only a few inches. After the explosion, about one-third of the displacement occurring in the ground roll will remain as a permanent distortion. That is, the ground will be deeply fissured, cracked, and distorted in a jagged mosaic-like pattern.

b. These effects will cover more area if the surface layer is composed of clays or semiconsolidated materials and less area if the overburden is loose soil, sands, or gravels. If dense consolidated sub-strata lie within a few hundred feet of the surface, the ground roll will be intensified by energy reflected into the surface layer.

66. Radioactive contamination. When the burst is low enough for the ball of fire to touch the ground, both fission particles and neutron-induced radioactive elements will be mingled with the ground debris.* The coarser materials will fall out near the crater. The finer materials and dusts, which probably carry the majority of the radioactive contaminants, will be carried up in the blast cloud and may be expected to settle out slowly by gravity or to be washed down in rains over the surrounding areas in a manner and to a degree which remains unknown. Consequently, pending controlled tests in remote areas, the on-ground or underground burst must be used with caution in tactical situations where friendly personnel may be endangered. If the winds between ground and 10,000 feet blow away from friendly areas for 24 hours, or if the cloud can be expected to drift away 200 miles or more before the wind changes unfavorably,

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* In direct contrast to air burst heights above 600 feet, in which all radioactive radiation-hazards disappear very quickly. See paragraph 14b.

the operation may be assumed to be safe. However, the area within several thousand feet of the crater may be unsafe to occupy during the first month following the explosion.* The area of the crater lip and the crater proper will be both contaminated and broken up so as to be impassable.

67. The diagram of Figure 15 illustrates the expected areas of damage from a 20 KT underground burst at 50-foot depth in the absence of wind.

AN EMPIRICAL ANALYTICAL BASIS FOR PREDICTING CASUALTIES

68. Distribution in distance. It is likely that the casualties produced by atomic explosions, in common with other weapons, have a normal (Gaussian) distribution. This may be expected, since troops generally will be randomly oriented both in attitude and in situation. Furthermore, the number of ways and the means from which deaths, wounds, or injuries can occur will be large. If these conditions are satisfied, the distribution of casualties as a function of distance should follow an error function of the form

$$F(r) = \exp\left[-\tfrac{1}{2}\left(\frac{r-a}{\sigma}\right)^2\right] \text{for } r \geqslant a, \qquad (7)$$

where

r = distance from burst point

$F(r)$ = fraction of troops at distance r who become casualties

a = limiting distance for overkilling or overdamaging the target

$F(r) = 1$ for $r \leqslant a$.

69. For example, if the data for percentage of deaths at different distances from burst point are plotted for the Hiroshima experience, the curve so found, which may be called the "Hiroshima Death Function," can be written as:

$$D(r) = 0.93 \exp\left[-0.693\left(\frac{r-800}{850}\right)^2\right] \text{for } r \geqslant 800,$$

where r is the slant distance in yards from the point of burst. This function is plotted as the smooth curve in Figure 16, in comparison with the actual data points** represented by small circles. The close agreement between

* The two principal forms of radioactive contamination-hazard are: 1) a penetrating gamma radiation from relatively large amounts of radioactive elements in an area; 2) radioactive poisoning from the ingestion of relatively minute amounts of radioactive materials.

** The Effects of Atomic Weapons; p. 376, Figure 12.15.

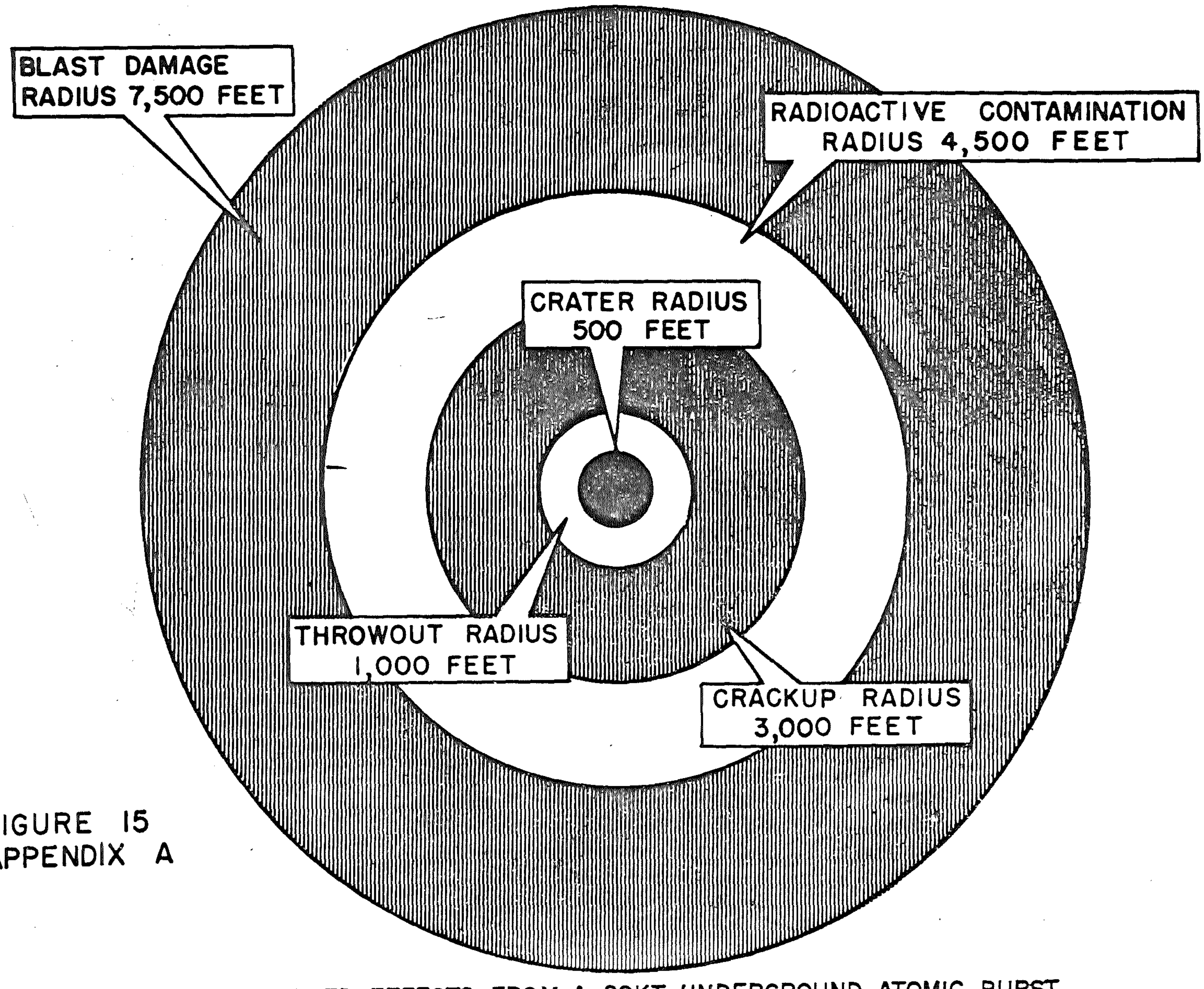


FIGURE 15
APPENDIX A

ESTIMATED EFFECTS FROM A 20KT UNDERGROUND ATOMIC BURST
AT A DEPTH OF 50 FEET—NO WIND

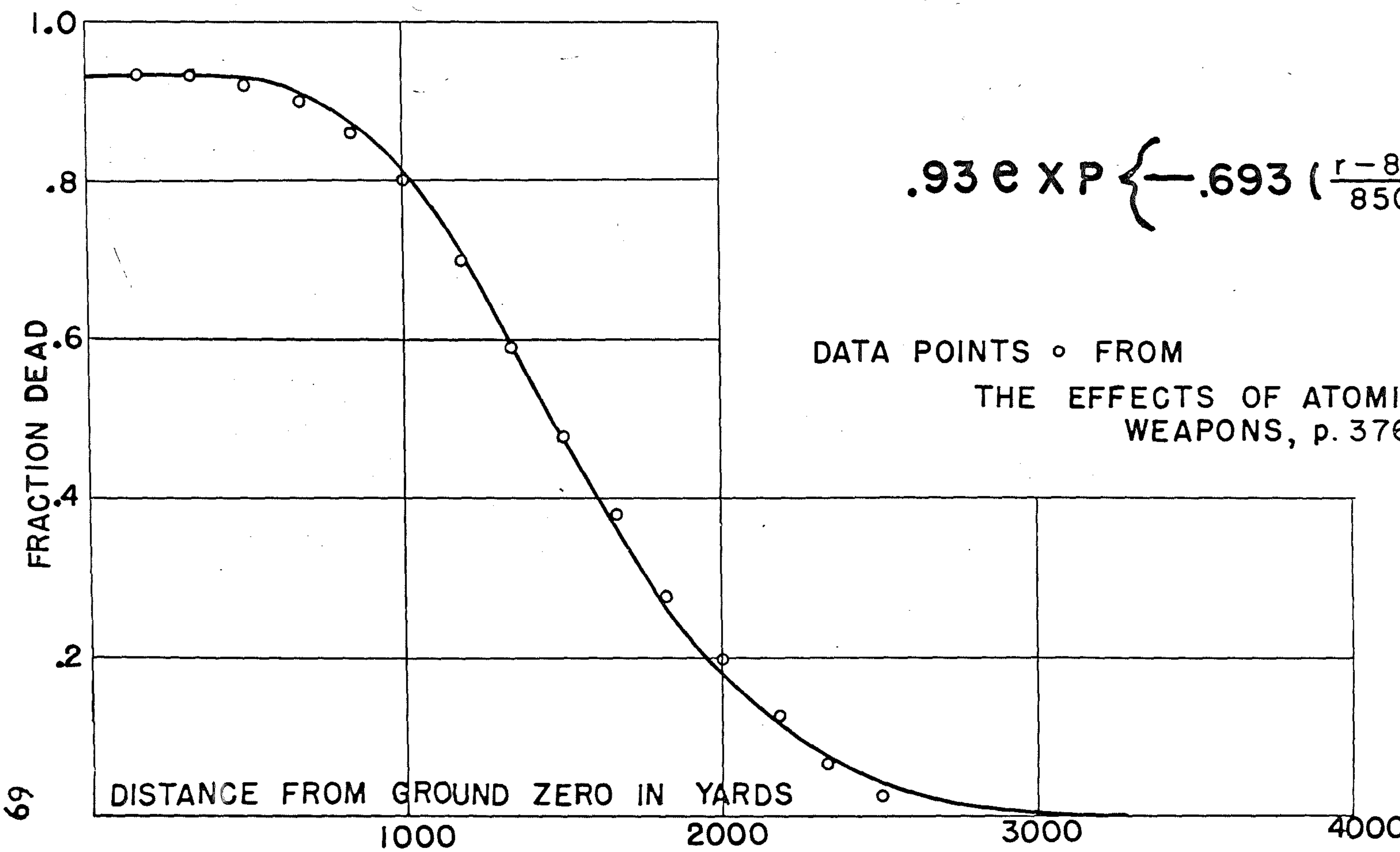
ESTIMATED EFFECTS FROM A 20KT UNDERGROUND ATOMIC BURST AT A DEPTH OF 50 FEET—NO WIND

FIG. 16 APPENDIX -A-

HIROSHIMA DEATH FUNCTION

MORTALITY VS. DISTANCE FROM GROUND ZERO COMPARED WITH A NORMAL DISTRIBUTION FUNCTION FOR SLANT DISTANCE $r \geqq 800$ YARDS

$$.93 \, \exp\left\{-.693\left(\frac{r-800}{850}\right)^2\right\}$$



DATA POINTS o FROM THE EFFECTS OF ATOMIC WEAPONS, p. 376

experience and an empirical error-distribution curve is not necessarily surprising, since the conditions for randomness given in paragraph 68 probably were met and the sample was large (70,000 dead or missing).

70. For purposes of analysis it is more convenient to use an approximation

$$D(y) = 0.93 \exp\left[-0.693\left(\frac{y-500}{1000}\right)^2\right] \text{for } y \geqslant 500,$$

for the Hiroshima Death Function, where y is the distance in yards from ground zero.

71. In the present paper, all curves expressing expected casualty fractions vs distances from ground zero will be given in the form

$$C(y) = \exp\left[-0.693\left(\frac{y-a}{b}\right)^2\right] \text{for } y \geqslant a, \quad (8)*$$

72. The use of equation (8) in casualty predictions has two distinct advantages:

(a) It is an analytical form which can be readily used in computations;

(b) It allows a complete casualty curve to be drawn, once the values of two parameters have been chosen.

73. In fixing values for the parameters a and b, it is convenient to use any two of the following three distances from ground zero:

(a) $y = a$, the maximum distance to which the target is overkilled.
(b) $y = a + b$, the distance corresponding to a casualty fraction of $\frac{1}{2}$.
(c) $y = a + 3b$, the distance beyond which casualties become negligible.

However, none of these distance is yet known with much accuracy for ground-force targets, so comparisons between all three for consistency and reasonableness may be required before fixing values for a and b.

74. The three distances listed above can be compared with the resistance of the target to blast overpressure and thermal radiation as functions of distance from ground zero.

* Since $e^{-0.693} = \frac{1}{2}$, this expression is identical with $(\frac{1}{2})$ raised to the power $\left(\frac{y-a}{b}\right)^2$; i.e., $b = 1.177\sigma$; see equation (7).

Thus, in the Hiroshima case* the distance of overkilling, y = 500 yards, corresponded to a blast overpressure of about 28 psi, which produces mass distortion of heavy steel-frame buildings with loss of roofs and panels. At the 50-percent mortality distance, y = 1500 yards, the overpressure was 9 psi; major structural damage occurred to all buildings, many collapsed, and much high speed, blast-blown debris was generated. The limiting distance for deaths, y = 3500 yards, corresponded to a blast overpressure of about 2 psi, with partial damage of structures in the area, and to thermal radiation of about 2.5 calories/cm^2, approximately the lowest illumination capable of producing skin burns or igniting dry combustible materials.

Effects of Atomic Weapons on Personnel and Cover

75. In the absence of data from the actual tactical employment of atomic weapons against ground-force targets, estimates of casualties and damage to material necessarily must be based on the Hiroshima and Nagasaki experiences, supplemented by such other sources of information as may be judged applicable and dependable.

76. Reliability of data. The effects of atomic airbursts upon structures are known with reasonable accuracy and can be checked against the damage observed at Hiroshima and Nagasaki. Thermal-radiation effects upon personnel and materials were less accurately observed at Hiroshima and Nagasaki, but have been supplemented by measurements made in various laboratories. Blast effects on trees and natural cover remain to be measured, so the estimates given below may be considerably in error. The effects of acute gamma-radiation doses on human beings are based partly on estimates and partly on extrapolations from experiments with animals. However, as mentioned earlier, gamma radiation has limited tactical significance against troops in the open or under nominal cover, since its effectiveness is limited to an area near ground zero, usually subject to overkilling by blast and thermal radiation. An important exception occurs under very hazy atmospheric conditions. If the visibility is sufficiently low, gamma radiation will be comparable with or may override thermal radiation in damage to exposed personnel.

77. Energies required for blast and thermal radiation damage. Estimates of casualties based upon thermal illumination levels are given in Table VII, gamma-ray dosages given in Table VIII, and blast overpressures given in Table IX.

* Effects of Atomic Weapons: Tables 5.45 and 6.50.

TABLE VII

DAMAGE BY THERMAL RADIATION

Calories/cm^2	Effect
2.5	Threshold for skin burns and for ignition of dry leaf or grass specimen.
5.	Severe skin burns and high pain-level, foliage scorched.
10. to 12.	Charring or ignition of clothing; general fires in dead fuels.

TABLE VIII

DAMAGE BY GAMMA RADIATION

Whole Body Dosage in Roentgens	Effect
50	Threshold for injury; no disability.
400	Sickness within 7 days, followed by temporary recovery, then 50 percent mortality after several weeks.
700	Sickness within 24 hours; all eventually die.

TABLE IX

DAMAGE BY AIR BLAST

Overpressure (psi)	Effect
2	Threshold of blast damage to frame buildings.
3	Threshold of blast damage to trees, (estimated).
4	Blow-down of Korean huts (estimated).
5	Threshold for deaths inflicted by light ground debris.
6	Collapse of wooden barracks and light frame buildings.
7	Mass blow-down of conifers, (estimated). Destruction of multi-story bearing-wall brick buildings.
8	Blow-down of broadleaf trees in leaf, (estimated). Destruction of light concrete and steel-frame buildings.
10	Destruction of heavy brick and stone masonry.
20	Destruction of all buildings except reinforced concrete.

78. Assignment of values to parameters in troop death functions. In order to assign values to the parameters a and b in the Troop Death Function

$$D(y) = \exp\left[-0.693\left(\frac{y-a}{b}\right)^2\right] \qquad (9)$$

for various target conditions, the following assumptions will be made by analogy with the Hiroshima Death Function:

(a) The distance from ground zero, $y = (a + 3b)$, corresponding to a negligible fraction of deaths, will coincide with the distance for the threshold of moderate blast or thermal damage to personnel or cover or both.

(b) If target damage is caused principally by air blast, the 50 percent mortality distance, y = (a + b), will coincide with the distance for the virtually complete destruction of substantial cover and the generation of high speed, blast-blown debris.

(c) If target damage is caused principally by thermal radiation, the 50 percent mortality distance, y = (a + b), will be the distance at which clothing is charred or ignited over considerable areas of the body.

(d) The maximum overkilling distance, y = a, will never be less than the distance for a whole body gamma-ray dose of 700 roentgens, and may be greater if other means of injury contribute.

(e) The minimum distance for a negligible mortality fraction among troops will never be less than the distance at which blast-blown equipment and light debris from the ground attain sufficient speeds to inflict death.

79. Target-damage levels corresponding to each of the assumptions stated in paragraph 78 can be selected from Tables VII, VIII, and IX.

(a) Under assumption (a) of paragraph 78, the distance y = (a + 3b) for a negligible fraction of deaths will be the distance from ground zero at which: (1) the illumination is 2.5 calories/cm^2 for troops exposed to thermal radiation; (2) the blast overpressure is 2 psi for troops billeted or deployed in built-up areas; (3) the blast overpressure is 3 psi for troops in woods.

(b) Assumption (b), paragraph 78, indicates that the 50 percent mortality distance, y = (a + b), for troops in towns, villages, farm buildings, and wooded areas, will be the distance from ground zero at which the blast overpressure is about 8 psi. The 50 percent mortality distance at Hiroshima occurred at overpressures of 9 psi, but the attack was made against an area of strong structures, including reinforced-concrete buildings of aseismic design. Table VIII indicates that overpressures of 4 to 8 psi will level the type of construction more likely to predominate in army tactical situations. However, it is felt that the leveling of relatively frail structures must be accompanied by violent blow-down and high-speed debris if heavy casualties are to result. Consequently, an overpressure of 8 psi will be chosen in the present discussion rather than the actual overpressures required to level structures in the target area.

(c) The 50-percent-mortality distance, y = (a + b), for troops exposed to thermal radiation, assumption (c), paragraph 78, will be the distance at which the illumination is 10 to 12 calories/cm^2, provided appreciable areas of their bodies are illuminated. That is, the altitude angle of the ball of fire must be high enough to minimize shade (about 20 to 30 degrees). Furthermore, the 50-percent-mortality distance for prone or entrenched troops will be different than for erect or marching troops and will also depend upon meteorological conditions at the time of the burst.

80. Distances from ground zero corresponding to y = (a + b) and y = (a + 3b) (hence values for a and b) for various target conditions, burst heights, weapon energies, and meteorological conditions can be found by reference to Figure 4 for blast overpressure and to Figures 5 and 6 for thermal illumination of horizontal and vertical targets on clear and on hazy days.

81. On very hazy days, the burst height must be lowered if maximum casualties are to be inflicted on troops in open ground by radiation. In this case, the overkilling distance, y = a, will be determined by the combined effects of gamma and thermal radiation and blast-blown ground debris while the distance for a negligible fraction of deaths, y = (a + 3b), will be determined by blast-blown debris. Figures 4, 7, and 8 give applicable data for estimating these two distances.

82. <u>Vulnerability classes of troop targets</u>. When the procedures outline in paragraphs 78-81 are applied to fix approximate values for the parameters <u>a</u> and <u>b</u> in the death function for various troop targets, it is found that most "soft" personnel targets may be divided according to vulnerability into three fairly distinct categories or classes for which:

a. The 50-percent-mortality distances, y = (a + b), measured from ground zero for a 40 KT burst are approximately 2100, 1750, and 1500 yards respectively;

b. The limiting distances for negligible mortality, y = (a + 3b), are approximately 4300, 3250, and 2500 yards, respectively.

c. The distances of overkilling, y = a, lie in the neighborhood of 1000 yards for all three classes.

83. It follows that these vulnerability classes have the approximate values for parameters <u>a</u> and <u>b</u> shown in Table X.

TABLE X

VALUES OF PARAMETERS GIVING EXPECTED TROOP DEATHS

ACCORDING TO VULNERABILITY TO A 40 KT AIR BURST

Vulnerability Class	a (yards)	b (yards)
A	1000	1100
B	1000	750
C	1000	500

84. The following target conditions are representative of each vulnerability class:

a. Vulnerability Class A.

(1) Troops on march, in assembly, or working on open ground (including field artillerymen) on clear days when the visibility range is about 12 miles.

(2) Troops in and among bearing-wall buildings of frame, brick or light masonry construction.

(3) Troops moving through woods composed of **conifers** or **soft-wood** trees in leaf, assuming that no holocaust fires develop.*

(4) Troops surprised away from prepared positions for more than about 2 seconds, in the open on a clear day, or among trees or light buildings.

(5) Horse cavalry.

(6) Troops with poor indoctrination in atomic defense.

b. Vulnerability Class B.

(1) Troops caught in march, assembly, or work in the open on hazy days when the visibility is about 6 miles.

* See paragraph 94a for a discussion of probable casualties from forest fires.

(2) Prone troops in the open on average-to-rough ground.

(3) Troops in shallow-to-average entrenchments and foxholes on clear days. Troops in hardwood forests.

(4) Troops dug-in in woods, assuming no holocaust fires.*

(5) Troops billeted in tents in the open or in sparse natural cover.

(6) Troops with atomic defense indoctrination, but surprised by atomic attack.

c. Vulnerability Class C.

(1) Well dug-in troops in deep foxholes at zero time on hazy days, with visibility about 6 miles.

(2) Troops, either prone or in average entrenchments on open ground on very hazy days; visibility 2.5 miles.

85. Distribution of casualties by type. In the Hiroshima and Nagasaki experiences the ratio of the injured to the killed and missing was 1:1.** The present discussion will consider two types of casualty: (1) battle-field deaths, (2) wounds and injuries which cause immediate disability. In the absence of battle experience in the employment of atomic weapons against ground forces, it will be assumed that the ratio of death to incapacitating injury is 1:1 and that both are caused by the same set of physical agents. In other words, the distinction between death and incapacitating injury will be assumed to depend only upon accidental variations in the degree of physical injury inflicted. It follows that the parameter b will be the same in the death function as in the incapacitation function. That is,

$$I\ (y) = \exp\left[-0.693\left(\frac{y-A}{b}\right)^2\right] \qquad (10)$$

where the incapacitation function, I (y), includes both deaths and incapacitating injuries.

86. It should be pointed out that the assumptions made in the preceding paragraphs apply to the immediate but

* See paragraph 94a.

** Effects of Atomic Weapons; p. 336, Table 11.8.

not necessarily to the total casualties. For example, atomic-weapon casualties incurred from minor injuries, infection, lack of medical care, psychological effects, and disorganization may be caused by a set of agents different from those responsible for immediate death or incapacitating injuries, and consequently may have different distributions.

87. Values of the parameter A in the incapacitation function. Values for the parameters in the incapacitation function, equation (10), could be fixed by the same type of procedure used in fixing values for the parameters in the death function, equation (9). This procedure would be redundant, however, in view of the assumptions that the total numbers incapacitated in large targets consist of deaths and incapacitating injuries in equal proportions and that they are caused by the same set of physical agents. These assumptions give:

$$A = b\left(-1.06+\sqrt{\frac{2a^2}{b^2}+\frac{4.26a}{b}+2.58}\right) \qquad (11)$$

TABLE XI

PARAMETERS FOR FUNCTIONS GIVING EXPECTED INCAPACITATING CASUALTIES (INCLUDING DEATHS) FROM 40 KT AIR BURSTS FOR THREE VULNERABILITY CLASSES OF TROOP TARGETS

Vulnerability Class	A (yards)	b (yards)
A	1950	1100
B	1800	750
C	1650	500

88. Total and average deaths and incapacitations in an area. The casualty function, equation (8), can be integrated to give either the total or the average casualties in a target area. The fraction, F, of all troops, in a uniform circular target of radius $\bar{y}$, ($\bar{y} \gg a$), who become casualties is given by:

$$F = \frac{b^2}{\bar{y}^2}\left[\left(\frac{a}{b}\right)^2 + 2.13\left(\frac{a}{b}\right)P + 1.44\left(1-0.5p^2\right)\right] \qquad (12)$$

where $p = \frac{\bar{y}-a}{b}$

$$P = \frac{2}{\sqrt{\pi}}\int_0^{0.832p} e^{-z^2}dz \qquad \text{(the probability integral)}$$

as those outlined in this report for constructing casualty curves for personnel. However, present accuracy of knowledge (January 1951) of equipment damage does not appear to justify this procedure.

101. Burst heights to maximize damage to structures and equipment. Whenever structures and equipment, and their associated personnel, in a target (a major CP, for example) are more important than other personnel in the area, the burst height obviously should be chosen to damage severely the objects of greatest military value. The choice of burst height then would be made by following the methods outlined earlier, after first determining, of course, by reference to tables or graphs (such as Tables VII, VIII, IX, XIII) what blast overpressure or other weapon effect is required to severely damage or to destroy the target.

102. If the blast overpressures required to produce severe damage of structures or equipment in a target lie in the range 15 psi to 6 psi, the corresponding optimum heights of burst to maximize damage lie in the range 2500 to 4000 feet for a 40 KT air burst. (See Figure 4.) If an appropriate burst height can be chosen within this range, the loss in the maximum area of personnel casualties will be relatively small.

103. If the required blast overpressure is higher than about 30 psi, the radius of the area of severe damage by a 40 KT air burst will be less than 1000 yards, and consequently, an underground burst of 20 to 40 KT would become competitive.*

104. Combined effects on equipment and personnel. Frequently, a rough pictorial presentation of the approximate combined damage distances for both equipment and personnel is useful. Accordingly, the following definitions of damage to personnel will be used in constructing Figure 24:

a. Severe damage to personnel will extend to a distance from ground zero at which 50 percent of the personnel in a unit area are killed and most of the survivors incapacitated.

b. Moderate damage will extend to a distance at which five percent are killed and about half incapacitated.

c. Light damage will extend to a distance where about five percent are incapacitated with very few killed.

* See paragraphs 62-67 and 94(b), and Figure 15.

If there are n troops per unit area in the target, the total number of casualties, N, is given by:

$$N = \pi y^2 nF \qquad (13)$$

89. Equation (13) has an asymptotic value for $y > (a + 3b)$ given by:

$$N = \pi n\ (a^2 + 2.13ab + 1.44b^2) \qquad (14)$$

(In equations (12) and (14), the parameter b is common to both the death and the incapacitation functions, but a should be replaced by A if the incapacitation function is used).

90. The data in Table X (or XI) can be used in conjunction with equation (14) in estimating total casualties in large uniform troop-target areas.

TABLE XII

TOTAL DEATHS AND DEATHS PLUS INCAPACITATING INJURIES

FROM A 40 KT AIR BURST OVER LARGE TROOP TARGETS

Vulnerability Class	N/n (millions of square yards)*	
	Deaths	Total of Incapacitations
A	15.9	31.8
B	10.7	21.4
C	7.6	15.2

* To obtain N, multiply numbers in the columns by n, the average number of troops per million square yards.

Construction of Casualty Curves.

91. Casualty curves, based on equations (9), (10), (11), (12) and (13) can be readily constructed, once the values of the parameters a, A, and b have been determined or assumed for the death and incapacitation functions. Curves showing fractional casualties as a function of distance from ground zero, and average and total casualties in uniform circular targets as functions of distance from ground zero, are given in Figures 17 to 23 for the three classes of troop targets listed in paragraph 84.

92. Uses of casualty curves. The casualty curves of

FIG. 17 EXPECTED CASUALTY FRACTIONS VS. DISTANCE FROM GROUND ZERO FOR 40 KT AIRBURST AT HEIGHT OF 3000 - 3500 FEET.
VULNERABILITY CLASS A [SEE PARAGRAPH 84 (a)]

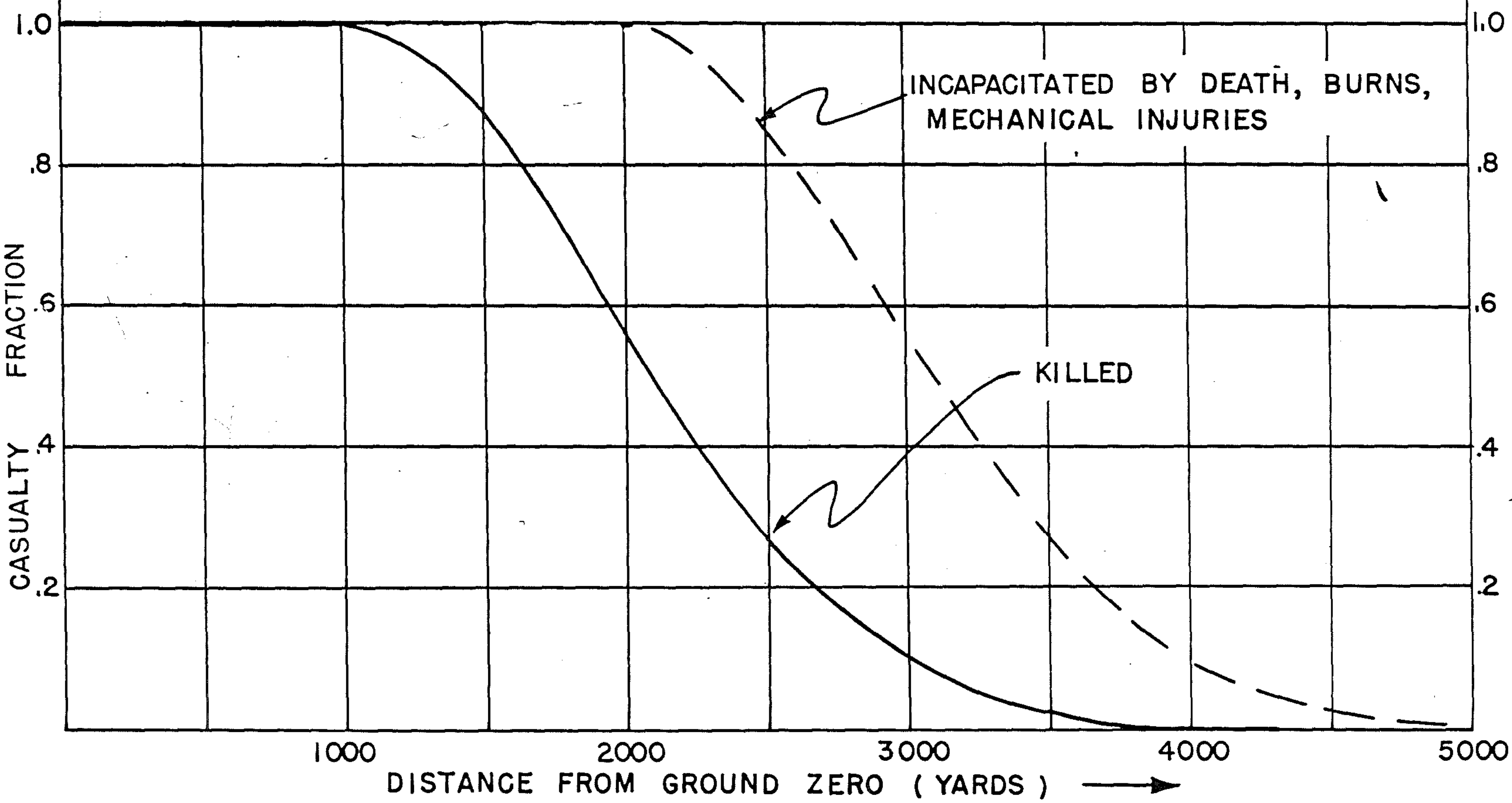
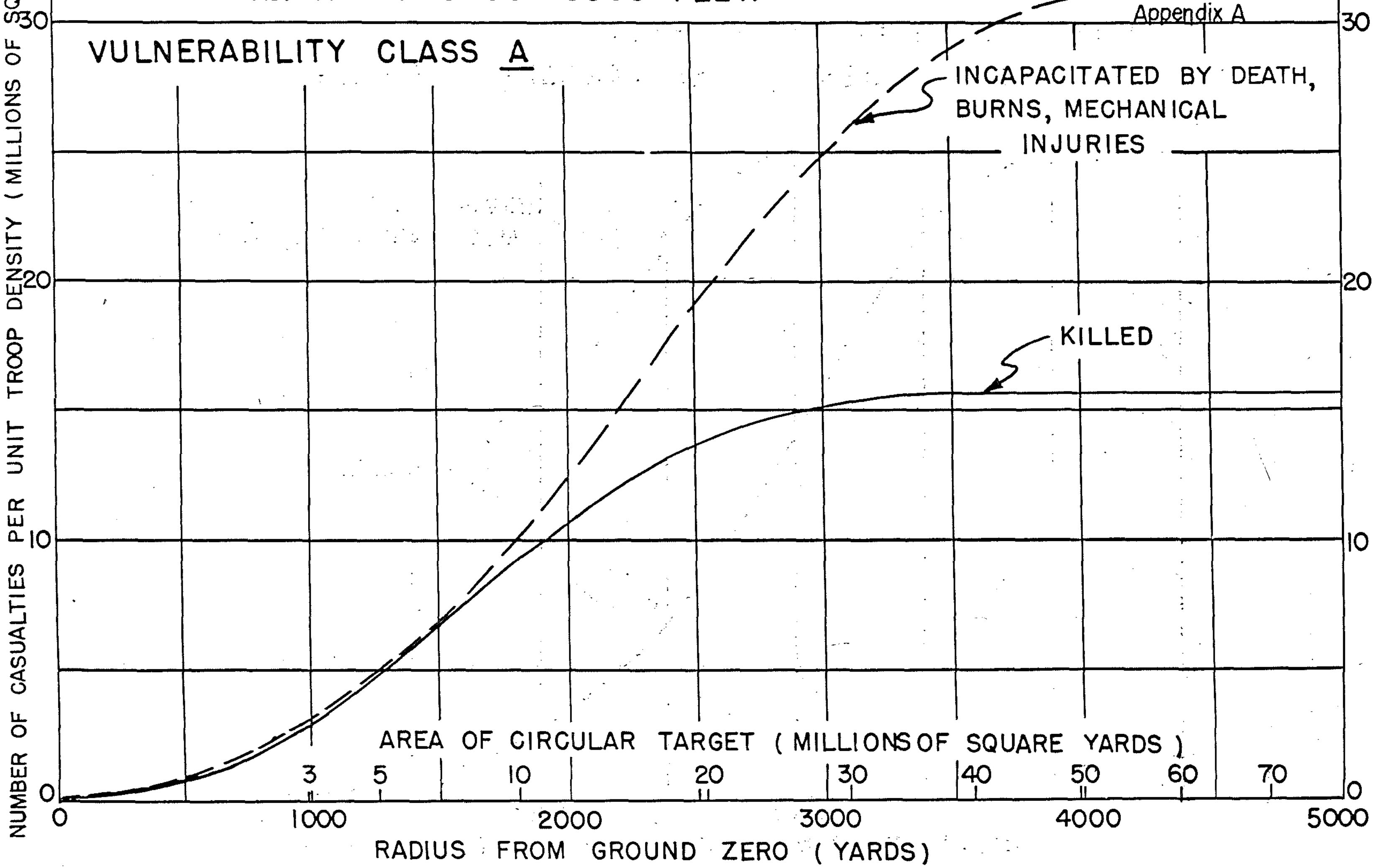


FIG. 18 EXPECTED CASUALTIES IN A UNIFORM CIRCULAR TARGET AREA VS. TARGET RADIUS AND AREA FOR A 40KT AIRBURST AT A HEIGHT OF 3000-3500 FEET.



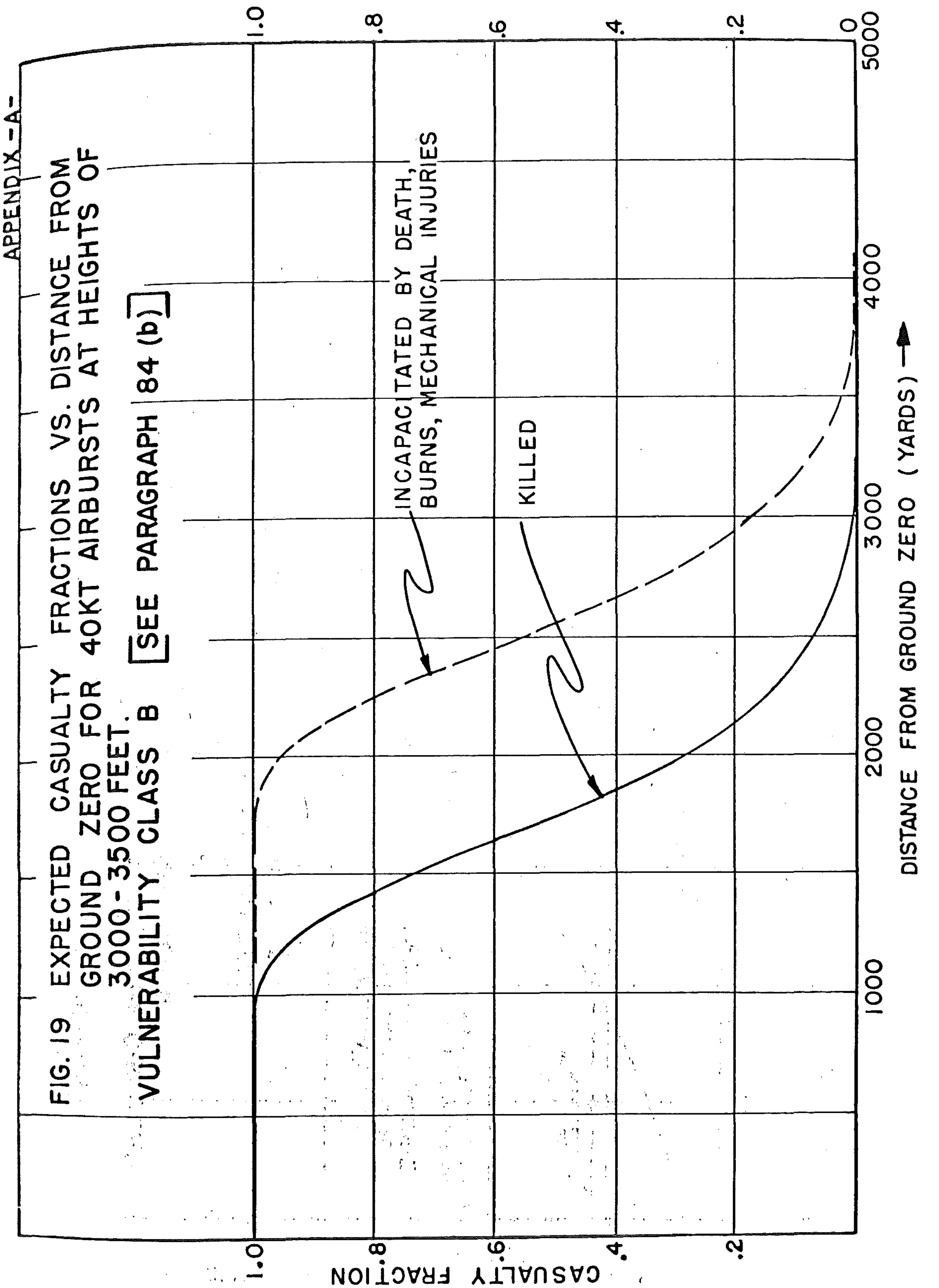


FIG. 19 EXPECTED CASUALTY FRACTIONS VS. DISTANCE FROM GROUND ZERO FOR 40KT AIRBURSTS AT HEIGHTS OF 3000-3500 FEET.
VULNERABILITY CLASS B [SEE PARAGRAPH 84 (b)]

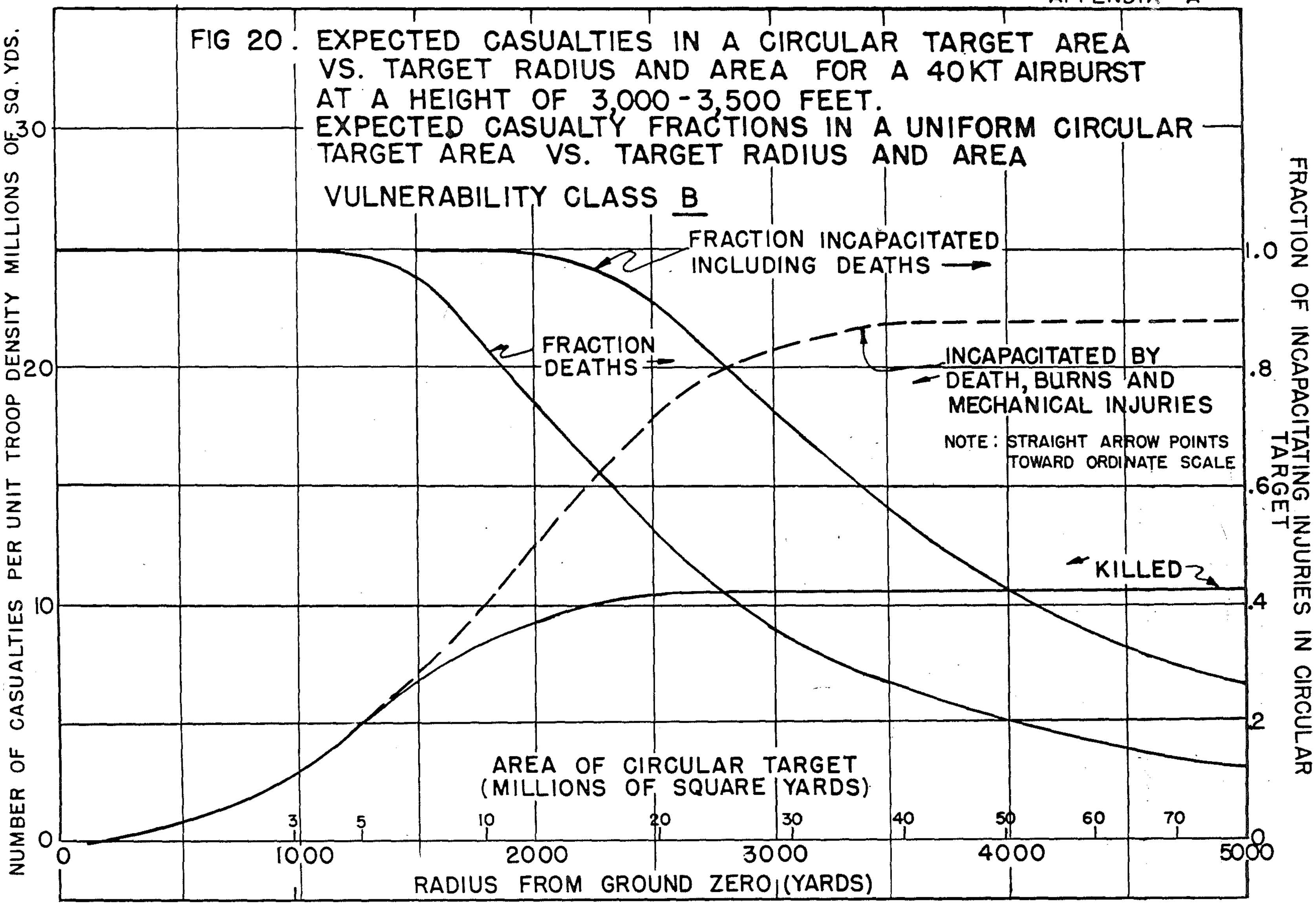


FIG 20. EXPECTED CASUALTIES IN A CIRCULAR TARGET AREA VS. TARGET RADIUS AND AREA FOR A 40KT AIRBURST AT A HEIGHT OF 3,000-3,500 FEET.
EXPECTED CASUALTY FRACTIONS IN A UNIFORM CIRCULAR TARGET AREA VS. TARGET RADIUS AND AREA

APPENDIX A

FIG. 21 EXPECTED CASUALTY FRACTIONS VS. DISTANCE FROM GROUND ZERO FOR 40KT AIRBURSTS AT HEIGHTS OF 2500 - 3000 FEET.

VULNERABILITY CLASS C [SEE PARAGRAPH 84 (c)]

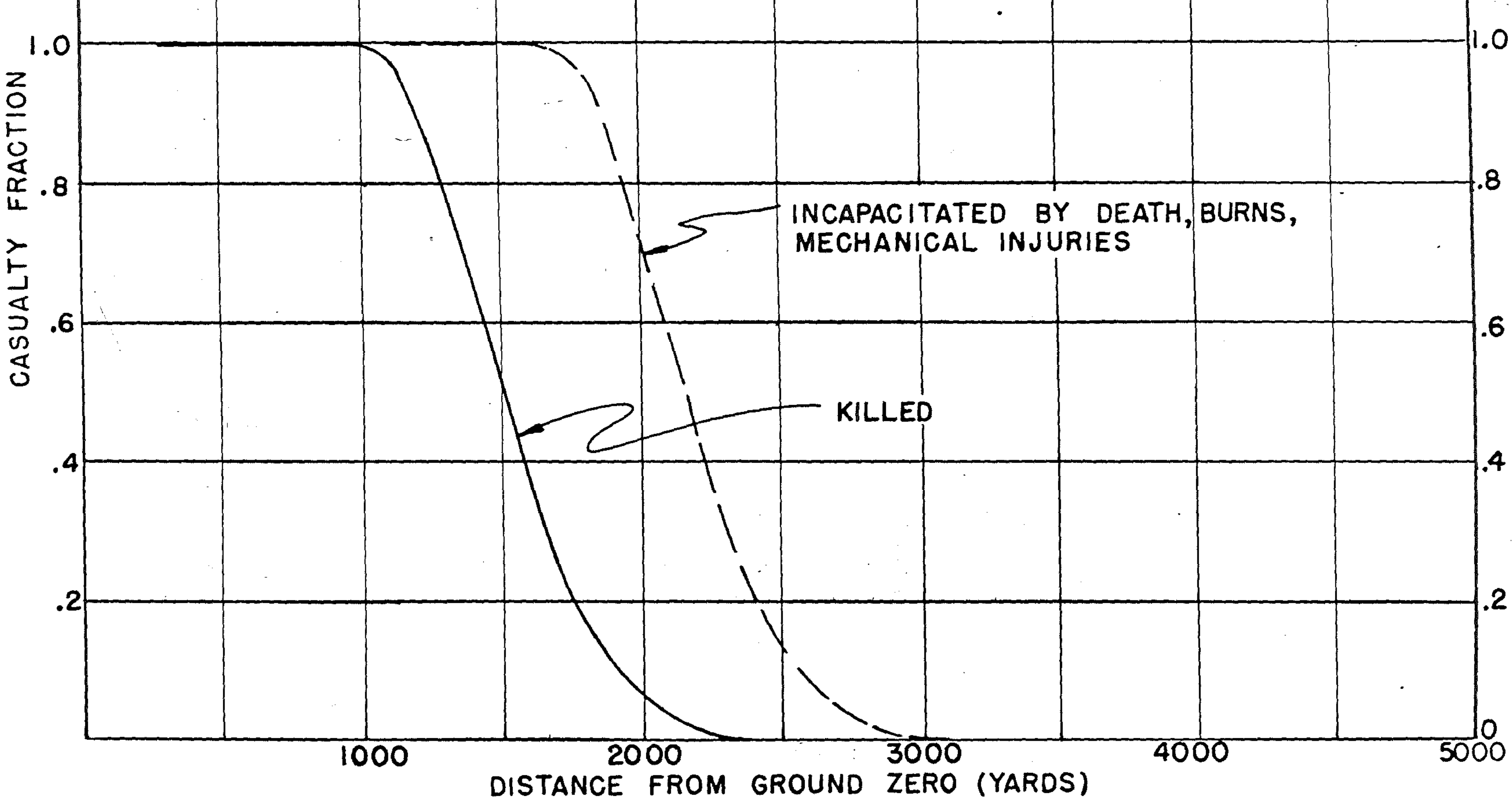
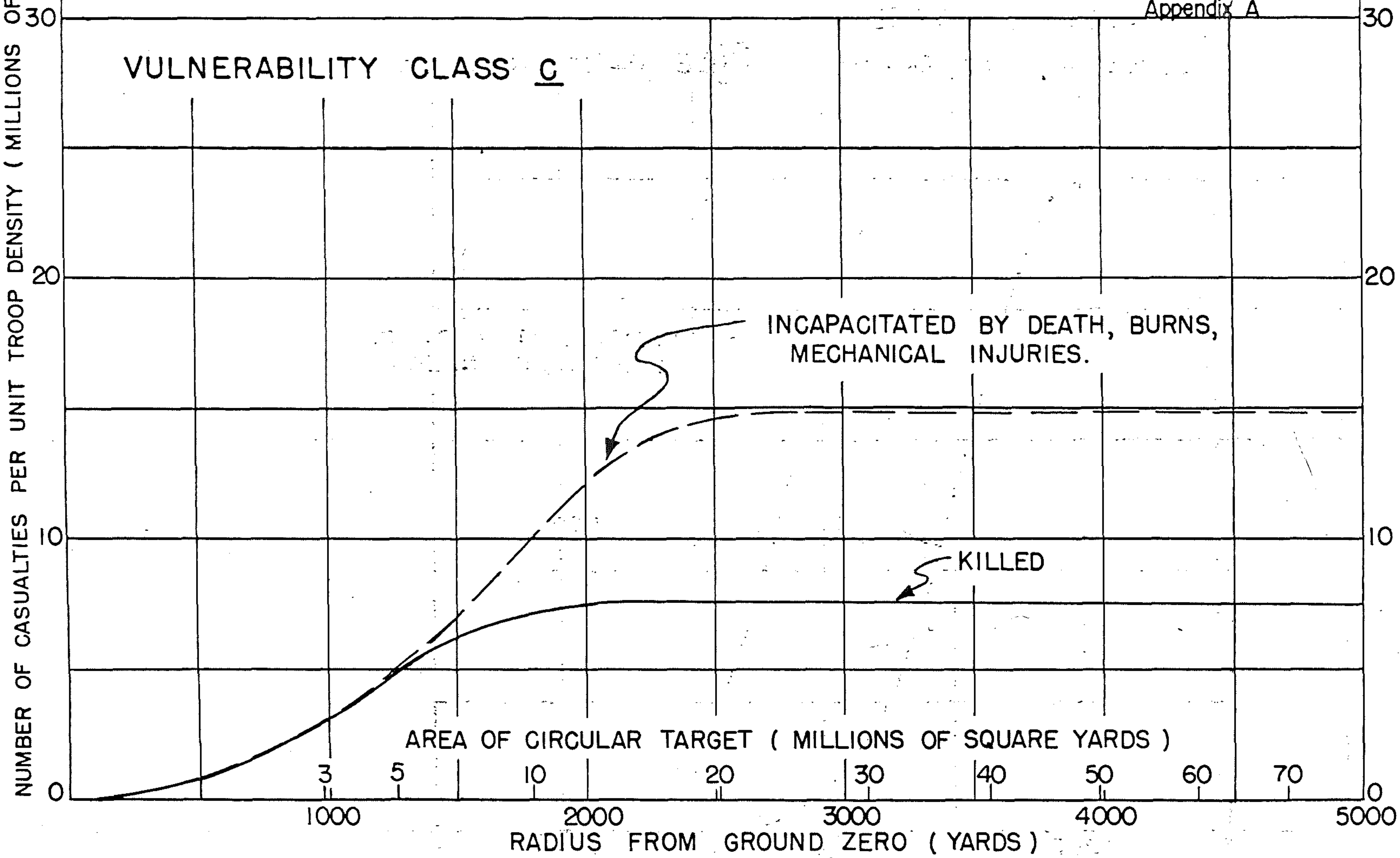


FIG. 22 EXPECTED CASUALTIES IN A UNIFORM CIRCULAR TARGET AREA VS TARGET RADIUS AND AREA FOR A 40 KT AIRBURST AT A HEIGHT OF 2500 - 3000 FT.



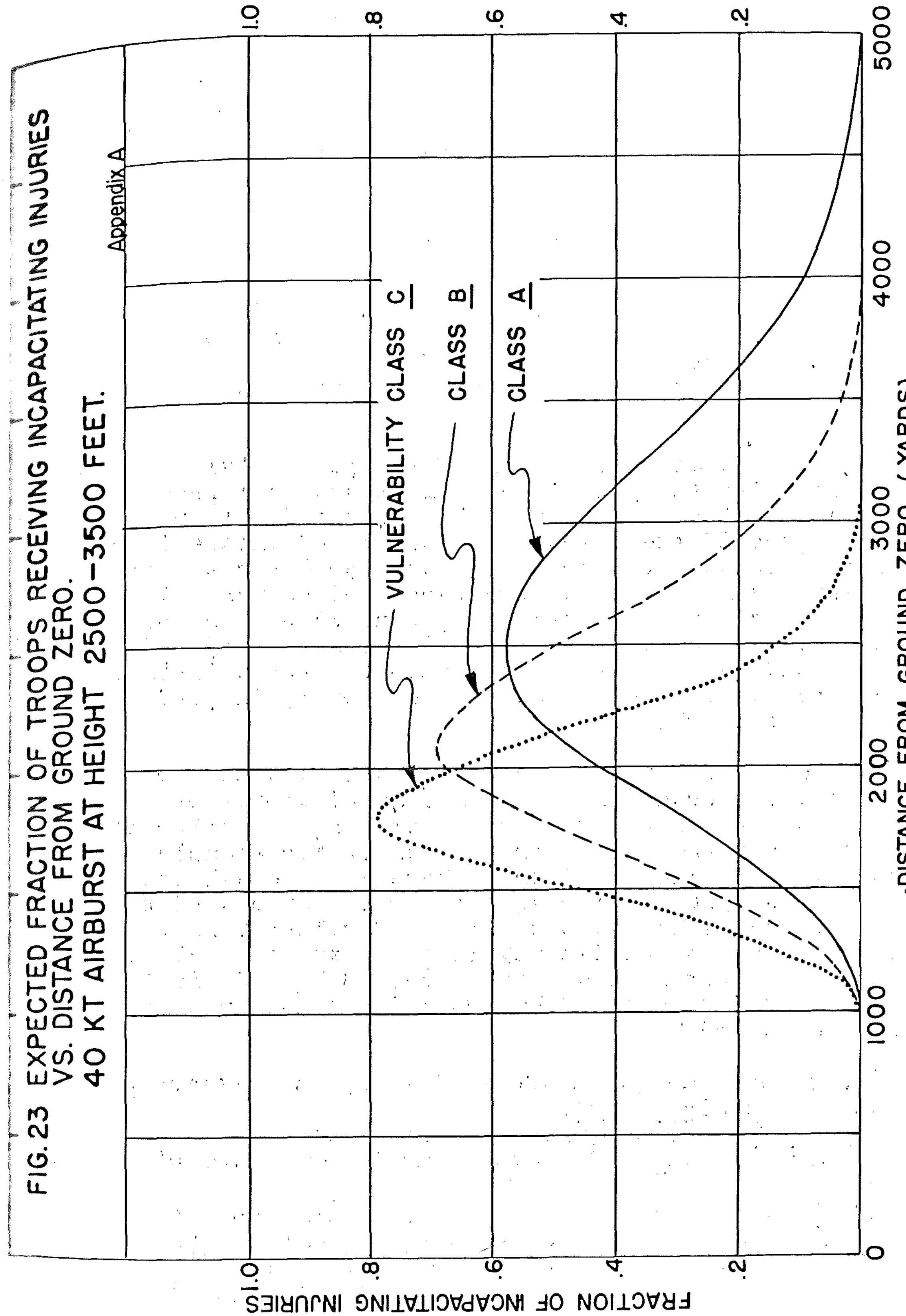


FIG. 23 EXPECTED FRACTION OF TROOPS RECEIVING INCAPACITATING INJURIES VS. DISTANCE FROM GROUND ZERO.
40 KT AIRBURST AT HEIGHT 2500–3500 FEET.

Figures 17-23 present seven types of information on each of the three principal vulnerability classes of troop targets:

a. Expected fraction of troops killed, D(y), as a function of distance from ground zero. For example, Figure 17 indicates that in targets of vulnerability class A, deaths would be expected to be 10 percent, on the average, among troops 3000 yards from ground zero for a 40 KT air burst at a height of 3000 to 3500 feet.

b. Expected fraction of troops removed from action by death and incapacitating injuries, I(y), as a function of distance from ground zero. For example, Figure 17 indicates expected casualties of 55 percent among troops 3000 yards from ground zero in a target of vulnerability class A.

c. Expected fraction of troops receiving incapacitating injuries as a function of distance from ground zero; i.e., the fraction incapacitated minus the fraction dead. Thus in Figure 23 the average percentage of incapacitating injuries expected among troops located 3000 yards from ground zero is 45 percent for a target of vulnerability class A. At distances closer to ground zero than the maxima of the curves shown in Figure 23, desperately injured casualties would be expected to predominate, while farther from ground zero than the maxima, seriously injured casualties would be the more numerous.

d. The total number of troops expected to be killed on the average, N (D), in terms of troops per million square yards, n, in a circular target, as a function of the radius of the target about ground zero.* For example, in Figure 20, it is indicated that there will be 9.3 troops killed per men per million square yards inside a circle of 2000 yards radius in a troop target of vulnerability class B. Thus, if the troop density in this target is 500 men per million square yards, the total expected killed within 2000 yards of ground zero would be 500 x 9.3 = 4650 men out of a total of about 6300.

---

* The reader should carefully distinguish between ground zero and the aiming point.

Ground zero is the point on the ground on the vertical line through the actual point of burst (or center of the ball of fire).

Aiming point is the point on the ground on the vertical line through the point at which the weapon was meant to explode. See paragraphs 15 and 18-35, and Annex 1, Appendix B, for discussions of the effect of atomic weapon delivery-errors on troop casualties.

e. The total number of troops, expected to be incapacitated by death and injury, N (I), in a circular target, as a function of the radius of the target. At large distances from ground zero, the number incapacitated becomes twice the number killed. Within the radius of overkilling, the number incapacitated is, of course, the number of dead; i.e., all are killed.

f. The fraction of all troops present expected to be killed, F (D), within a circular target, as a function of the radius of the target.

g. The fraction of all troops present expected to be incapacitated by death or injury, F (I), within a circular target as a function of the radius of the target.

93. Scaling law for casualty curves. Blast effects scale accurately, and thermal-radiation effects approximately, as the cube root of the energy release. Consequently, the casualty curves referring to distances, (Figures 17, 19, 21, and 23) can be used for other energy releases, W, by multiplying distances by $(W/40)^{1/3}$. In casualty curves referring to areas, (Figures 18, 20, and 22), the area scales would be multiplied by $(W/40)^{2/3}$ and the distance scales by $(W/40)^{1/3}$.

94. Miscellaneous factors affecting troop casualties from atomic weapons. a. Forest fire. Troops in woods are always vulnerable to tree blow-down and splinter-missile hazards. In addition, holocaust fires may develop if dry fuels are present* or if the forest foliage will support crown fires. In the course of such fires, troop deaths from oxygen depletion would be general in the burned area. Few of the incapacitated would escape death; i.e., the death function in Figure 17 would practically coincide with the incapacitation function.

b. Underground bursts. Casualties in the area surrounding an underground burst cannot be estimated with any confidence in the absence of tests to establish its physical effects. Assuming that in the absence of wind the effects are as shown in Figure 15, a rough estimate of casualties can be made as follows: first, estimate that the distance, y = a, for overkilling by cratering, throw-out, radioactive contamination, and ground crack-up is about 700 yards; next, estimate that the distance for negligible deaths, y = a + 3b, is 2500 yards. This gives a death

* See paragraph 23.

function

$$D(y) = \exp\left[-0.693\left(\frac{y-700}{600}\right)^2\right]$$

and an incapacitation function

$$I(y) = \exp\left[-0.693\left(\frac{y-1200}{600}\right)^2\right]$$

for a 20 KT explosion 50 feet underground. These functions give total expected deaths of about 5.5 troops per ~~man~~ men per million square yards, and total expected incapacitations of about 11 troops per ~~man~~ men per million square yards, in a circular target area. The scaling law for casualties in an area* then indicates that a 20 KT underground burst would cause about the same total casualties as a 20 KT air burst against a target of vulnerability class C, Table XII.

c. Miscellaneous effects. Appendix H identifies and defines eight types of injuries from atomic air bursts. The casualty curves, Figures 17-23, are based principally on estimates of deaths and disabling injuries from secondary blast traumata, primary and secondary burns, and gamma-radiation dosages. Casualties from disorganization, concussion, psychoses, and temporary impairment of vision are not considered,** nor has an allowance been made for minor non-disabling injuries which may develop into serious infections if medical first-aid facilities are overburdened.

ATOMIC WEAPON EFFECTS ON MATERIALS, EQUIPMENT, AND STRUCTURES

95. In the preceding discussion, the primary objective has been considered to be the infliction of maximum casualties on troops. However, the optimum burst-heights for maximizing thermal-radiation damage to troops in the open have been found to be compatible with the burst heights required to blow down the types of natural and artificial cover considered more likely to contain substantial numbers of troops. These burst heights have been shown to lie in the range 3000 to 3500 feet for a 40 KT atomic weapon, except for very hazy days when a compromise burst height of 2500 to 3000 feet is seen to be better if thermal damage to troops is an important associated objective.

96. In the following discussion, damage to materials, equipment, and structures will be considered from two viewpoints.

* See paragraph 93, preceding.
** See paragraph 86.

a. Damage when the height of burst for 40 KT is 3000 to 3500 feet.

b. The burst heights required to yield maximum areas of damage for various structures, materials, and equipment.

Since present information on thermal and blast damage to materials and equipment, including information from Bikini Test Able, is not very dependable, many of the values used in the following tables should be considered as estimates which may require change when more conclusive data become available.

97. Materials and equipment. The 3000- to 3500-foot burst height for 40 KT weapons, considered as optimum against personnel, will permit varying amounts of damage to materiel, as shown in Table XIII. In this table the degree of damage is given as severe, moderate, or light, as defined in the following:

a. Severe damage is that damage requiring major repairs or replacements at rear echelons before the materiel can be returned to service, thus definitely removing the equipment from the tactical situation.

b. Moderate damage is that damage requiring extensive repairs or replacements at either forward or rear echelons, causing the materiel to be removed from the battle area, although probably re-employable.

c. Light damage is that damage which may be repaired on location and which may not require removal from the tactical situation.

98. Table XIII gives the estimated blast overpressures required to produce a given level of damage to various types of army equipment, and the distances from ground zero to which these levels of damage extend when the burst height is 3000 to 3500 feet for a 40 KT weapon. Because this height of burst has been chosen to maximize damage to personnel, considered as the primary target, the severe effects on equipment are less than those produced at lower burst heights. For example, near ground zero, the maximum overpressure for a short distance is about 28 psi. This overpressure is not sufficient to damage tanks severely.

99. Other factors affecting equipment damage. Table XIII refers only to blast damage received in the open. In many cases, both personnel and equipment may tend to receive damage to about the same degree as the predominant vulnerable objects in their immediate neighborhood. Thus, all Army

equipment, including tanks, may be destroyed in a forest blow-down to a distance as great as 2500 yards from ground zero for a 40 KT burst at about 3500-feet height, if the blow-down is followed by holocaust fire.* As a further example, Korean experience has shown that tanks may be considerably more vulnerable to atomic attack than previously supposed. Napalm has accounted for roughly two-thirds of enemy tanks (T-34) destroyed by weapon attack.** The majority of these napalm tank-kills have been caused by external rubber fires in treads and bogie wheels, which develop sufficient heat to ignite internal oil fires or explode ammunition. Since synthetic rubber burns at thermal energies of 8 calories/cm^2***, tanks on which the treads and bogies are not shaded from the ball of fire may be killed as far as 2500 yards from ground zero for a 40 KT burst at 3500 feet height on a clear day, or up to 2000 yards away on a hazy day.

TABLE XIII

DISTANCE FROM GROUND ZERO VS. DEGREE OF BLAST DAMAGE TO FIELD EQUIPMENT BY 40 KT AIR BURSTS AT HEIGHTS OF 3000 TO 3500 FEET

Distances from Ground Zero (yards)
Associated Overpressures (psi)

Item	Severe		Moderate		Light	
	Yards	Psi	Yards	Psi	Yards	Psi
Tanks	None	40	250	25	2200	8
Trucks	1100	15	2600	6	3700	3
Artillery Field Pieces	Negligible	28	1100	15	2800	5
Electronic Equipment	1500	12	2800	5	3700	3
Military Light Steel Frame Buildings	2200	8	2800	5	3700	3
Aircraft on the Ground	3200	4	4200	2.5	5000	1.5

100. In principle, it should be possible to construct statistical casualty curves for equipment by the same methods

* See paragraph 94(a).
** ORO-R-1 (FEC), Employment of Armor in Korea.
*** The Effects of Atomic Weapons; p. 201, Table 6.50.

APPENDIX A

The casualty curves of Figure 17, 19, and 21 may be used in conjunction with the preceding definitions of personnel damage to construct Table XIV.

TABLE XIV

DISTANCE FROM GROUND ZERO VS. DEGREE OF

DAMAGE TO PERSONNEL* BY 40 KT AIR BURSTS

AT 3000 TO 3500 FEET HEIGHTS

Vulnerability Class**	Damage		
	Severe Yards	Moderate Yards	Light Yards
A	2100	3250	4300
B	1750	2550	3400
C	1500	2050	2700

* Pack, transport and cavalry animals will be vulnerable to atomic attacks to essentially the same degree as personnel in the same situation and type of cover.

** See paragraph 84 for definition of vulnerability class.

SUMMARY OF ATOMIC WEAPON EFFECTS ON GROUND FORCE TARGETS

105. The various atomic-weapon effects on ground-force targets have been discussed in the present paper in such detail and to such degrees of confidence as available knowledge in January 1951 may justify.

106. The approximate effects on Army equipment and personnel of 40 KT air bursts at heights of 3000 to 3500 feet are shown graphically in Figure 24. A diagram of this type is necessarily only approximate. For details on the effects of such factors as varying burst heights, topography, meteorology, underground bursts, natural and artificial cover, and atomic weapons of other than 40 KT TNT equival the reader should consult appropriate sections of the pr paper, or other references.

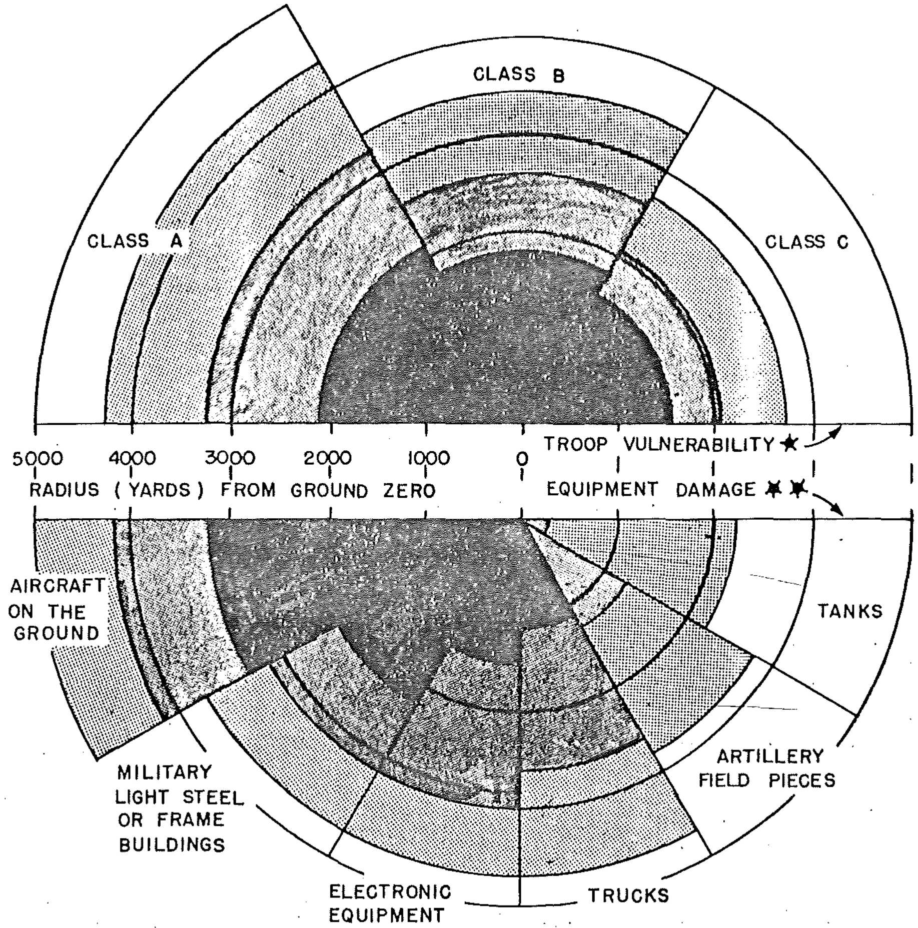
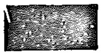


FIG. 24 APPROXIMATE DAMAGE LEVELS INFLICTED ON TROOPS AND EQUIPMENT BY 40KT ATOMIC AIRBURSTS AT HEIGHTS OF 3000 ± 500 FEET.

★ SEE PARAGRAPH 84.
★★ SEE PARAGRAPHS 97, 99 AND 106



SEVERE DAMAGE

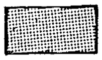
DEFINED AS THAT DAMAGE REQUIRING MAJOR REPAIRS AND / OR, REPLACEMENTS BY REAR ECHELONS BEFORE POSSIBLY BECOMING SERVICEABLE AGAIN ; DEFINITELY REMOVED FROM TACTICAL SITUATION.

AT THE AREA'S OUTER BOUNDARY, ABOUT HALF OF THE PERSONNEL ARE KILLED AND MOST SURVIVORS ARE INCAPACITATED.

MODERATE DAMAGE

DEFINED AS THAT DAMAGE REQUIRING EXTENSIVE REPAIRS AND / OR, REPLACEMENT BY EITHER FORWARD OR REAR ECHELONS ; PROBABLY RE-EMPLOYABLE, BUT REMOVED LARGELY FROM THE TACTICAL SITUATION.

AT THE AREA'S OUTER BOUNDARY, ABOUT 5 PERCENT OF THE PERSONNEL ARE KILLED ; ABOUT HALF ARE INCAPACITATED.



LIGHT DAMAGE

DEFINED AS DAMAGE WHICH MAY BE REPAIRED ON LOCATION ; MAY POSSIBLY NOT BE REMOVED FROM THE TACTICAL SITUATION.

AT THE AREA'S OUTER BOUNDARY, ABOUT 5 PERCENT OF THE PERSONNEL ARE INCAPACITATED BUT VERY FEW ARE KILLED. INJURIES REQUIRING FIRST AID WILL EXTEND BEYOND THIS AREA.

APPENDIX B

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APPENDIX B

ANALYSIS OF TARGETS AND TACTICS

INTRODUCTION

Purpose

1. Targets and tactics in general are considered in detail, for their bearing on methods for using atomic weapons tactically in support of ground operations.

2. CCF tactics are considered, to determine their application to methods of employing atomic weapons tactically.

Probable Army Use

3. Attacks on extended targets with conventional high explosives, delivered by carpet bombing or by concentrated area artillery fires, are both much higher in total cost and appreciably less effective than similar attacks made with atomic weapons.* Consequently, it is likely that atomic warheads, initially numbering hundreds, and later numbering thousands, may be employed in ground operations in any war between major military powers.

4. The extensive use of atomic weapons by both sides will force significant changes in Army organization, equipment, and tactics. The tactical deployment of both UN and enemy forces in Korea appears to make them vulnerable to possible attack with atomic weapons.**

5. For definiteness in discussion, it will be assumed that the available weapon is a 40-KT atomic bomb delivered by a medium or heavy bomber comparable to the B-29. However, a number of press releases during the past year have indicated that atomic-weapons technology may be expected soon to provide for delivery by other means, including artillery, guided missiles and fighter or light bomber aircraft.***

---

* See Appendix I.

** See Appendices C and G.

*** See Appendix E.

TACTICAL TARGETS*

Target Types

6. a. A partial list of Army targets which may be attacked effectively with atomic warheads follows:

(1) Reserve troops in assembly areas, before crossing lines of departure.
(2) Bridge-, beach-, or airheads.
(3) Troops committed to an offensive, especially when attacking in mass or from strength in depth.
(4) Aircraft on the ground.
(5) Reserve troops in bivouac.
(6) Horse cavalry and pack animals, any situation.
(7) Troops occupying towns.
(8) Penetrations in force.
(9) Troops in defensive positions, particularly MLR, artillery and services.
(10) Artillery concentrations and major gun groups.
(11) Airfields and airdromes, their buildings, logistics, equipment and services.
(12) Personnel and materiel in marshalling and staging areas.
(13) Small salients and strong pockets of resistance.
(14) Fortified positions, including dominating heights and reverse slope positions.
(15) Blocking positions astride MSR.
(16) Vehicle and motor transport parks.
(17) Principal POL and supply depots and dumps.
(18) Command Posts at division, corps and army levels.
(19) Bridges.
(20) Tanks and armored cavalry.
(21) Deep valley and gorge routes.
(22) Airfield runways and landing strips.

b. Targets in the first part of this list are generally "soft" and can be attacked by air-burst atomic warheads; targets near the end of the list are "hard" and require low air bursts, or surface or underground bursts. The softer targets usually will be more attractive and profitable than the harder targets for atomic attack.

---

* See Annex 1 of this Appendix for a more quantitative discussion of target evaluation than that presented here.

Target Evaluation

7. Some targets, such as key positions and major CP's, can be evaluated only in terms of their influence on the over-all situation. Other targets can be evaluated in terms of area and concentration. From the viewpoint of dollar cost the analysis in Appendix I shows that most targets of extended area can be attacked more cheaply with atomic warheads than with conventional weapons.

8. Quick estimates of expected casualties for troop concentrations can be made from paragraph 90, Table XII, and figures 18, 20, and 22 in Appendix A. The curves given in Annex 1 of this Appendix also may be used for rough estimates of expected casualties. More precise estimates of casualties to troops and of damage to other types of targets require that such factors as terrain, cover, meteorology, and (sometimes) geology, be taken into account. Timely and accurate intelligence, discussed in Appendix C, is required for dependable target evaluation.

PLANNING AND EXECUTION OF ATOMIC ATTACK

Korean Theater

9. In the Korean theater, the planning and execution of atomic attacks will require that command control and decision be located in the theater, presumably at Army level (see Appendix F)* in order that the time between target identification and attack may be minimized. This conclusion follows automatically, both from the fluid situation and from the peculiar tactical and logistical practices of the North Korean Army and Chinese Communist Forces.

10. The command and logistic organization required for mounting atomic attacks with medium bombers is discussed in detail in Appendix F. From a technical viewpoint, the following actions are required if an atomic attack is to be delivered effectively and safely:

Location and Identification of Target

11. Location and identification includes an estimate of the approximate size, nature, and distribution of the target from air reconnaissance, ground patrols, or other intelligence sources (see Appendices C and D). Either the target center or its periphery or both must be determined as accurately as possible so that ground zeroes for atomic burst-points can be set if it is decided to attack the target. Conditions of local terrain and cover often can be used to indicate the

* For future weapons, see also Appendix D.

probable target limits.*

Damage Prediction**

12. Damage prediction is made on the basis of:

a. The area, concentration, and distribution of the target.

b. Kind and degree of natural and artificial cover.

c. Terrain and major topographical features.

d. Prevailing and predicted meteorological conditions.

e. Optimum burst height and ground zero.

f. Probable delivery accuracy.

g. Timing of the strike.

h. Local geology, if pertinent.

Specification of Aiming Point and Burst Height

13. Choice as to aiming point and burst height follow automatically from damage prediction.

Command Decision

14. The decision gives place, time, and method of strike, and plan of exploitation.

Delivery Accuracy

15. The accuracy requirement is variable with the size and nature of the target, degree and kind of damage desired, and location of own troops. For many tactical targets, (less than 3,000 yards in radius) the expected percentage of area damaged increases as the CPE*** is decreased until a CPE of 200 yards is reached. Smaller CPE's do not increase the effectiveness of the attack, except in a few special cases involving very hard targets. A CPE of 500 to 1,000 yards is acceptable against soft targets having radii of more than 3,000 yards, but will not produce as much damage on the

* See paragraph 61, Appendix A.

** See Appendix A for a detailed discussion of damage prediction.

*** See paragraphs 18-20 and 34.

average as will a 200-yard CPE unless the target is large and uniform.

Safety of Friendly Troops

16. Appendix A, paragraphs 68-94, analyzes in detail an empirical method for predicting troop casualties. Basic to this analysis is the definition of a distance from actual ground zero beyond which casualties become negligible in the sense that the energy received from an atomic explosion is insufficient to produce death or incapacitating injury at that distance. This distance (called y = a + 3b in the Death Function, and y = A + 3b in the Incapacitation Function, equations (9) and (10) respectively, of Appendix A) obviously is the minimum safe distance from actual ground zero.

17. By the use of values for the parameters, a, A, and b given in Tables X and XI of Appendix A, a table of safe distances from actual ground zero (Table I) can be constructed for the three classes of troop vulnerability defined in paragraph 84 of Appendix A.

TABLE I

MINIMUM SAFE DISTANCES IN YARDS FROM ACTUAL

GROUND ZERO FOR A 40 KT* AIR BURST

Vulnerability Class	To Avoid Death (a + 3b)	To Avoid Incapacitating Injury (A + 3b)
A	4300	5250
B	3250	4050
C	2500	3150

* To obtain safe distances for other A-Weapons of energy W, multiply the distances in this table by $(W/40)^{1/3}$.

18. The distances given above are measured from actual ground zero. An additional safety distance for friendly forward elements may be added to allow for inaccuracies in the delivery of the weapon. Delivery accuracy usually is measured ~~in terms~~ of the CPE, the radius of the circle of probable error, called CEP by US Air Force. The circle of probable error is the circle inside which one-half of all bombs fall; the remaining half fall at greater distances from the aiming point.

19. CPE has an experimentally verifiable mathematical basis. The number of bombs falling outside one CPE, two CPE, and so on can be calculated. However, in ground operations, only the fraction of bombs falling at a distance from the aiming point and in the direction toward friendly troops adversely affects their safety. Thus, for an aiming point in front of a friendly line, the actual ground zero under an air burst may be, say, 500 yards from the aiming point. The troop-safety question is: how much of this 500-yard error is in a direction toward friendly lines? For example, the 500-yard error may be represented by the hypotenuse of a right triangle with a 300-yard leg toward the friendly line and a 400-yard leg parallel to it; or the whole 500-yard error may be in a direction away from friendly lines; and so on.

20. Table II gives the fractions of all bombs which may be expected to fall outside of circles of various radii, and also the fractions of all bombs which may be expected to fall outside of strips of various widths. The common center of these circles is, of course, the aiming point; the common side of the various strips (more literally, half strips)* is a line through the aiming point and parallel to the friendly troop line. The remaining side of each half-strip is parallel to the common side and lies between the aiming point and the friendly troop line. (In other words, only those bombs will be considered which fall outside these half-strips and toward friendly troops.) The radii of the various circles and the widths of the various half-strips are given in whole- and half-integral multiples of CPE in Table II.

21. As an example of the use of Tables I and II, suppose that the CPE for bombing is 500 yards and that it is desired to drop an atomic weapon by aircraft on an aiming point 6,000 yards in front of a line of friendly troops, some of whom may be exposed in the open, and therefore are of Class A vulnerability. By reference to Table I it is seen that in this case the minimum safe distance to avoid death is exceeded by 1700 yards or nearly 3.5 (CPE) and that the minimum safe distance to avoid serious injury is exceeded by 750 yards or 1.5 (CPE). Entering Table II with these numbers, it is seen that the chance of the bomb falling short toward the friendly line by 3.5 (CPE) or more is only .00002; i.e., only 2 bombs in 100,000 would be expected to fall close enough to produce the extremely small percentage of deaths indicated on the tail of the Class A Death Function curve of Figure 17, Appendix A.

* The other half of the strip is the part more remote from friendly troop lines.

TABLE II

DISTRIBUTION OF ACTUAL GROUND ZEROES ABOUT THE AIMING POINT AS A FUNCTION OF DISTANCE FROM AIMING POINT: (1) IN RANDOM DIRECTIONS, (2) IN THE DIRECTION OF A FIXED LINE

Distance S from aiming point (in CPE)	(1) Fraction falling outside a circle of radius S	(2) Fraction falling outside a half-strip of width S and toward a fixed line
0.0	1.0	0.50
0.5	0.83	0.28
1.0	0.50	0.12
1.5	0.213	0.039
2.0	0.063	0.0093
2.5	0.013	0.0016
3.0	0.002	0.0002
3.5	0.0003	0.00002
4.0	0.00002	-------

22. Again referring to Table II for 1.5 (CPE), it is seen that the chance of producing some small percentage of serious injuries to exposed friendly troops is 0.039. That is, about 4 bombs out of each 100 would be expected to fall within 5,250 yards or less of the friendly troop line.

23. Now consider the bombs which might fall 4,500 yards or less from friendly troop lines and therefore produce additional injuries. Since 6000-4500 = 1500 yards = 3(CPE), Table II shows that only 0.0002 bombs; i.e., 2 bombs in 10,000, would fall as close as this (or closer). Referring again to Figure 17, Appendix A, it is seen that if this unlikely event occurred, no deaths would be expected* and only 3 percent of exposed troops at 4,500 yards distance would be seriously injured. Furthermore, only troops at the nearest point forward would suffer even this percentage of casualties, since troops to their left, right, and back of them would be still farther from the burst point. Consequently in this example, the risk to friendly troops appears acceptably small, even though the added safety distance is only 1.5 (CPE) forward from friendly troops.

---

* Actually, the chance is 10 to 1 that there will be no deaths. Referring back to Table II, it is seen that of the fraction 0.0002 falling at 3 (CPE) or greater distances toward friendly lines, a tenth, or 0.00002, will fall as far as 3.5 (CPE) and hence at or inside the limiting distance for deaths.

24. If friendly troops had surrounded the aiming point in the example just given, the chance of a bomb falling at various distances from them would be read, of course, from the column in Table II which gives the fractions expected to fall outside circles of various radii. It will be noted that these fractions involve random directions and are therefore considerably higher than the fractions falling in the direction of a fixed line.

25. In the manner previously illustrated, Tables I and II can be used as a basis for either: selecting an aiming point at a reasonably safe distance from fixed friendly positions; or alternatively, withdrawing friendly troops to a reasonably safe distance from a fixed aiming point.

26. Calculated risks. The safe distances from actual ground zero given in Table I preceding may be slightly increased under some conditions of terrain or weather: for example, in a valley which tends to channelize air blast, or on an exceptionally clear day (visibility greater than 25 miles) when atmospheric attenuation of thermal radiation is near its minimum. In the discussion following it will be assumed, therefore, that the zero casualty distance from actual ground zero for a 40-KT air burst is 5500 yards (5 kilometers) for Class A targets under terrain and weather conditions tending to produce maximum damage-distances for troops in the open or in poor cover.

27. Similarly, if troops are forewarned and are crouched in deep* foxholes or are in "buttoned-up" tanks at zero time, (Class C targets), the zero casualty distance from actual ground zero will be assumed to be about 3500 yards. However, a calculated risk is involved, since such troops as had failed to receive or follow instructions would receive casualties. That is, some of those who exposed themselves enough to become Class B targets would be injured, and some of those who exposed themselves as Class A targets would be injured or killed.

28. The analysis of the example in paragraph 21 preceding indicates that there are two factors which determine the danger to friendly troops. One is the fraction, I**

* A deep foxhole or trench, as used here, means one providing a shelter angle of 20 degrees or more for every part of the body. The shelter angle is measured from the horizontal in the direction of the planned air burst.

** I is, of course, an Incapacitation Function, similar to those used in Appendix A. Here, however, the zero casualty distances ($y = A + 3b$) are assumed as 5500 yards and 3500 yards for Class A and Class C targets respectively, instead of 5250 yards and 3150 yards, and the estimated damage distances have purposely been made larger than they probably actually are, since the safety of friendly troops in involved.

which will be injured at some distance, y, from actual ground zero. The other is the fraction, F, of atomic weapons which will fall at a distance, y, or less, from friendly troops and therefore produce a casualty fraction of I or more. Values of F and of I are given in Table III for Class A vulnerability and in Table IV* for Class C vulnerability. A 40-KT air burst and a CPE of 500 yards radius are assumed.

29. As an example of the use of these tables, refer first to the column in Table III for an aiming point 5,500 yards in front of friendly troops. This is the "safe distance" from actual ground zero for Class A targets. The table shows, however, that because of delivery errors, 50 percent of all weapons can be expected to produce zero or more casualties; 12 percent to produce 1 percent or more casualties; 1.5 percent to produce 5 percent or more casualties; and so on. In addition, the column shows that (50-12) or 38 percent of the weapons will produce between zero and 1 percent casualties; (12-1.5) or 10.5 percent will produce between 1 and 5 percent casualties, and so on. Furthermore, by multiplying the average fraction of casualties in a given casualty-fraction interval by the corresponding fraction of weapons in that interval and adding up the products, the total fraction of casualties which the weapon would be expected to produce on the average can be obtained. This fraction is called the INJURY EXPECTANCY in Tables III, IV, and V.

30. By comparing I and F, the calculated risk in using a single weapon can be obtained. Thus, in the column for 5500 yards in Table III, it can be seen that despite an INJURY EXPECTANCY of only about 0.6 percent total casualties, there is 1 chance in 10,000 that a random delivery error may produce casualties of 25 percent or more among friendly troops of Class A vulnerability at distance of 5,500 yards from the aiming point for a 40-KT weapon when the CPE is 500 yards.

31. If Table IV is examined in a similar manner for an aiming point at the "safe distance" of 3500 yards for Class C targets, it is seen that, in contrast with the case examined previously F does not fall off rapidly with increasing values of I, so that there is a 1 percent chance of a random delivery error producing 50 percent casualties, a risk which usually will be unacceptable. Turning now to an aiming point 4000 yards forward of friendly lines, it is seen in the appropriate column of Table IV that on the average, the casualties among

* Tables III and IV supersede Tables I and II of Appendix B of ORO-T-1 (FEC).

TABLE III

VULNERABILITY CLASS A:

FRACTIONS OF A-WEAPONS, F, EXPECTED TO PRODUCE TROOP INJURY FRACTIONS EQUALING OR EXCEEDING I, AS FUNCTIONS OF DISTANCE FROM AIMING POINT TO A FRIENDLY TROOP POSITION. CONDITIONS: TROOPS IN MAXIMUM EXPOSURE IN OPEN IN CLEAR WEATHER OR IN POOR COVER WITH POSSIBLE CHANNELIZING OF BLAST; 40 KT AIR BURST 500-YARD CPE (RADIUS)

Injury Fraction I	F FOR VARIOUS DISTANCES FROM AIMING POINT TO FRIENDLY LINE					
	4000 Yards	4500 Yards	5000 Yards	5500 Yards	6000 Yards	6500 Yards
0.00	.9998	.99	.88	.50	.12	.009
.01	.99	.88	.50	.12	.01	.002
.05	.91	.58	.16	.015	.0004	5×10^{-6}
.10	.78	.33	.056	.0025	4×10^{-5}	$< 10^{-6}$
.15	.65	.20	.023	.0007	7×10^{-6}	
.20	.53	.13	.011	.0003	2×10^{-6}	
.25	.42	.08	.005	.0001	$< 10^{-6}$	
.30	.33	.056	.0025	4×10^{-5}		
.35	.25	.035	.0015	15×10^{-6}		
.40	.20	.023	.0007	8×10^{-6}		
.50	.12	.009	.0002	2×10^{-6}		
.60	.07	.0035	6×10^{-5}	$< 10^{-6}$		
.70	.035	.001	16×10^{-6}			
.80	.015	.0004	4×10^{-6}			
.90	.0045	8×10^{-5}	$< 10^{-6}$			
1.00	.0002	2×10^{-6}				
Injury Expectancy	.256	.098	.041	.006	.0006	$< 4 \times 10^{-5}$

.80	.015	.0004	4×10^{-6}			
.90	.0045	8×10^{-5}	$< 10^{-6}$			
1.00	.0002	2×10^{-6}				
Injury Expectancy	.256	.098	.041	.006	.0006	$< 4 \times 10^{-5}$

TABLE IV

VULNERABILITY CLASS C:

FRACTIONS OF A-WEAPONS, F, EXPECTED TO PRODUCE TROOP INJURY FRACTIONS EQUALING OR EXCEEDING I, AS FUNCTIONS OF DISTANCE FROM AIMING POINT TO A FRIENDLY TROOP POSITION.
CONDITIONS: TROOPS IN 20 DEGREE FOXHOLES AT ZERO TIME;
40 KT AIR BURST 500 YARD CPE (RADIUS);
EXCEPTIONALLY CLEAR WEATHER AND POSSIBLE CHANNELING OF BLAST

Injury Fraction I	F FOR VARIOUS DISTANCES FROM AIMING POINT			
	3500 Yards	4000 Yards	4500 Yards	5000 Yards
0.00	0.50	0.12	0.009	0.0002
0.01	0.28	0.04	0.0016	2×10^{-5}
0.05	0.14	0.013	0.0003	3×10^{-6}
0.10	0.08	0.004	8×10^{-5}	$\sim 10^{-6}$
0.15	0.05	0.0025	4×10^{-5}	
0.20	0.04	0.0016	2×10^{-5}	
0.25	0.03	0.001	13×10^{-6}	
0.30	0.025	0.0006	9×10^{-6}	
0.35	0.02	0.0004	6×10^{-6}	
0.40	0.015	0.0003	3×10^{-6}	
0.50	0.01	0.0002	2×10^{-6}	
0.60	0.006	12×10^{-5}	$< 10^{-6}$	
0.70	0.003	5×10^{-5}		
0.80	0.0018	2×10^{-5}		
0.90	0.0009	1×10^{-5}		
1.00	0.0002	2×10^{-6}		
Injury Expectancy	0.075	0.002	$< 10^{-4}$	$< 10^{-6}$

TABLE V

INJURY EXPECTANCY DUE TO DELIVERY ERRORS FOR EXPOSED TROOPS IN THE NEIGHBORHOOD. CPE RADIUS 500 YARDS: 40 KT AIR BURST: VULNERABILITY CLASS A.

DISTANCE FROM AIMING POINT (YARDS)	0–1000	1000–2000	2000–3000	3000–4000
6000	(.0006)	(.0004)		
5500–6000	.003	.002		
5500	(.006)	(.004)	(.001)	
5000–5500	.02	.01	.003	
5000	(.04)	(.02)	(.005)	
4500–5000	.06	.04	.02	
4500	(.09)	(.07)	(.03)	(.003)
4000–4500	.15	.10	.05	.01
4000	(.23)	(.15)	(.07)	(.02)

DISTANCE TO RIGHT OR LEFT OF AIMING POINT (YARDS)

Note: Numbers in parentheses give INJURY EXPECTANCIES along line segments 1,000 yards in length. Numbers in blocks give INJURY EXPECTANCIES in areas of dimensions 1,000 yd X 500 yd.

friendly troops (INJURY EXPECTANCY) will be lower than for an aiming point 5500 yards in front of a Class A target; but on a calculated-risk basis there is now one chance in 1,000 of producing 25 percent or more casualties by delivery errors, even with the added safety distance of one CPE forward of a Class C target, compared with only one chance in 10,000 of producing 25 percent casualties in a Class A target with no added safety distance to allow for delivery errors.

32. In applying Tables III and IV it should be kept in mind that they apply to positions in thin lines--not to positions in depth. Thus, in Table III, the INJURY EXPECTANCY is about 0.6 percent for forward troops 5500 yards from the aiming point, but decreases to only a tenth as much for troops 500 yards farther back. Table V should be used for INJURY EXPECTANCIES in line segments or in elements of area if any dimension of the area is as great as 500 yards.

33. As a final example of the use of Tables III, IV, and V, consider a case in which friendly troops have been forewarned and are believed to be of Class C vulnerability. The columns in Table III (or Table V) for aiming points 4000, 4500 and 5000 yards forward of friendly Class A targets then could be used to estimate the chance of casualties among such troops as had not taken cover.

34. Tables III and IV also illustrate the importance of keeping the circular probable errors small if atomic weapons are to be used in close support. Thus for a 40-KT weapon, the parameter b in the casualty function is about 1000 yards for Class A targets and about 500 yards for Class C targets; i.e., two CPE and one CPE respectively, in the case of Tables III and IV. It follows that, if the CPE for Class C targets were made 250 yards instead of 500, columns in Table IV would be replaced by columns from Table III as follows:

a. The column for a safe distance of 3500 yards in Table IV would become identical with the more acceptable column for a safe distance of 5500 yards in Table III.

b. The column for 4000 yards in Table IV now would represent an increased safety distance of two CPE instead of one CPE and consequently would be replaced with the column from Table III for 6500 yards. In general, it is felt that the CPE should not exceed b/2. Since the casualty function parameter b for atomic weapons obeys the scaling law ($W^{1/3}/b$ is constant for any given target class) it follows that the CPE also should be chosen by the same scaling law, both from the standpoint of effectiveness against targets, and from the viewpoint of safety for friendly troops.

35. Friendly troops should be indoctrinated in passive-defense methods and should be warned of impending local atomic attacks, if feasible, so that they may take cover and so decrease their vulnerability. In fluid situations, forward elements may require ground-to-air IFF systems and radio links to rear CP's to maintain safety from friendly atomic attacks.

Target Marking and Local Ground Control Systems

36. Aiming point designation, guide-in, and tracking means must be provided if high delivery accuracy and adequate safety for friendly troops are to be maintained. These requirements are particularly exacting when atomic warheads are used in close support. The following paragraphs discuss examples of a few of many ground-control and target-marking systems which may be applicable. Other systems, not described here, include such developments as Oboe and Lacrosse in the United States and the British Decca radio navigation system.

37. When atomic weapons are delivered by piloted planes, these systems would be used in conjunction with conventional visual or radar bombing to provide an independent check against gross bombardier or pilot error. They also could be "zeroed in" on check points in areas where atomic attacks might become desirable. In these situations the bomb would not be released until approval from ground control was received. If it became necessary to abort the sortie, the bomb crew would disarm the bomb by removing the fissionable material and return to base either with the complete round in "safe" condition or with the fissionable material only.

38. If delivery were by rocket, guided missile, or pilotless plane, the ground control and tracking stations should be provided with means for dudding and/or harmlessly destroying the atomic warhead in case of a wild delivery.

39. If delivery were by artillery-fired atomic projectiles, some device such as an integrating accelerometer might be incorporated in the round, or a velocity meter might be built into the gun tube, to prevent arming of the projectile in case of short fire. However, such devices may be undesirable complications in view of the comparative rarity of hangfire and short fires in modern artillery.

40. MPQ-2 Radar Tracking and Plotting Equipment

a. The MPQ-2 equipment is a specialized application of the SCR-584 gun-laying radar, by means of which the ground controller gives pilot and bombardier the following instructions by VHF radio telephone to effect either "blind" bombing or bombing with ground control:

(1) Course to be flown.
(2) Opening of bomb bay doors.
(3) Calling of time before bomb release.
(4) Concluding with command to release the bomb.

b. The technique of employment of the MPQ-2 gear requires careful preliminary planning. Approximately two days are required for set-up and preliminary checks, after which the system is available for use on about thirty minutes notice. Its effective range is about 25 miles. Subject to line-of-sight limitations, this range can be tripled if the bombing aircraft carries a responder beacon, the APW-2 Beacon. The equipment also functions better if the plane carries its own computer which computes the instant of bomb release by utilizing the prebriefed bomber altitude and ballistic data for the aummunition to be used. The ground gear is portable and is transported in two large vans. It requires a complement of four officers and thirty men, and may be moved on two to four hours notice.

41. <u>GCA Plane Tracking Equipment</u>: The Ground-Control Approach system consists of radar tracking gear (giving range, azimuth, and elevation) supplemented by a radiotelephone link from ground to plane for talking the pilot into position. GCA equipment has a maximum azimuth and elevation error of ten mils (milliradians) and a maximum range error of about 50 yards. The set has the radar line-of-sight range limitations. The effective range is 50 miles. The GCA equipment is proven gear which has been used throughout the world.

42. <u>Shoran</u>. <u>Shoran (short range aid to navigation)</u> is VHF radio-pulse equipment by means of which a plane or guided missile can measure its distances from each of two stations simultaneously and thereby establish its position. The equipment consists essentially of a master pulser and time-measuring circuits carried by the plane, and two slave stations, usually on the ground, which respond to and repeat the master pulse so that a Shoran operator (or automatic device) in the plane (or guided missile) can establish distances in terms of pulse transit-times to and from the slave stations. In principle, Shoran is one of the most accurate of present radio navigating systems. Its effective range is line-of-sight between the airborne master and both ground slave stations. The latter can use elevated antennas if necessary to increase range.

43. In the Mediterranean Theater, in ~~World War II,~~ it was demonstrated that bomb-release points could be marked and controlled by Shoran within a CPE of less than 150 yards, in two-thirds of the sorties flown. For some of the remaining

one-third of the sorties, there were no data to establish the bombing error, but in the majority of them gross Shoran-operator, bombardier, pilot, or equipment errors occurred.

44. This experience indicates that Shoran alone is insufficient and should be supplemented by separate tracking and command (or approval) means on the ground, to eliminate gross errors in close-support operations with atomic warheads. Since the same weaknesses are probably present in other navigating or guiding systems, it seems advisable to employ a separate (additional) ground station for tracking and command as a monitor in all cases where safety of friendly personnel must be guaranteed.

Observation of Target Damage

45. a. An atomic-warhead strike against a target should be followed up immediately by observation and reporting of target damage. The quickest and most satisfactory observations would be made from the air in two stages:

(1) Verbal reports by radio from spotter planes.
(2) Aerial photographs of the target area.*

b. In the instance of an air burst, the atomic cloud will have risen to a height of 25,000 feet within five minutes and aircraft can enter the area safely at altitudes up to 20,000 feet. In the instance of a very low air burst or ground burst, a somewhat longer period may be required for the cloud of radioactive dust to clear the area.

Multiple Aiming Points and Delivery Timing

46. The selection of multiple aiming points, and the delivery of several atomic warheads simultaneously or in rapid succession, often will be desirable in order to achieve surprise and decisiveness in neutralizing enemy sectors or concentration areas.** These actions will require close coordination and timing to maintain safety and effectiveness for friendly delivery-aircraft and to minimize the possibility of "fizzles" of atomic warheads.

47. Safety and effectiveness of friendly planes. If a plane enters the neighborhood during, or immediately after, an atomic explosion, the safety of plane and crew and their joint operational efficiencies are subject to the following hazards:

* See Appendix C, Annex 4.
** See Annex 4 and also Appendix C, Annex 1.

a. Air blast sufficient to damage the plane or deflect its bombing run;

b. Blinding of pilot or bombardier or loss of night vision from the atomic flash;

c. Excessive dosages to the crew of gamma radiation from the atomic cloud;

d. Condensation or collection of radioactive particles on the plane or through its ventilating system;

e. Radar clutter from masses of ionized air;

f. Target obscuration by dust, smoke, and secondary fires.

48. The first hazard determines the minimum safe dropping heights for atomic weapons by single planes and the safe spacing between planes delivering simultaneous attacks in line abreast. All six of the effects listed are pertinent if a series of air-burst weapons is to be delivered in the same region by successive serials of planes, but it will be shown below that only the third effect usually will be critical.

49. None of these effects need be important, however, for underground or underwater bursts. Delay fuzes could be used in these cases to permit safe retirement of all delivery aircraft without restriction on the safe height for dropping or dive bombing.

50. Following a high air burst, the minimum elapsed time before a plane can enter the area safely is set by the rate of rise of the atomic cloud. At an assumed safe dropping height of 20,000 feet for medium bombers such as the B-29*, this time would be five minutes in order to allow the atomic cloud to ascend to 25,000 feet or more** and thus make the hazards from gamma radiation and radioactive contamination acceptably low. This five-minute delay would place a 300-knot plane in any following serial about 50,000 yards from the explosion. A much faster aircraft than the B-29, say a 600-knot plane, might reduce the safe dropping height for an air-burst weapon of 40 KT or less to around 10,000 feet, and decrease the waiting time to about two and a half minutes for ascent of the atomic cloud to safe heights. This delay again would place the faster plane about 50,000 yards

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* See Appendix E, paragraph 4.

** The effects of Atomic Weapons; p. 33 and 275-77. See also Appendix A, paragraph 14b.

from the explosion. Consequently, none of the remaining hazards listed in paragraph 47 could be serious, except for possible visual obscuration of the target provided the prevailing ground winds have both sufficient speed and the correct direction to blow smoke or dust into unbombed areas.

51. Atomic weapon "fizzles." Stray neutrons in the atmosphere (mostly by-products of cosmic radiation) can cause a slightly premature atomic explosion of reduced energy, called a "fizzle." Vast numbers of neutrons are released by fission and by fission products during and in the first seconds following an atomic explosion. Although such neutrons are rapidly absorbed by capture in the surrounding air,* their initial numbers are so great that residual neutrons in excess of the normal density of atmospheric strays will persist in the neighborhood of an atomic explosion for many seconds, thereby increasing the probability of an atomic "fizzle" to an unacceptable degree. The probabilities of such fizzles obviously may be different for various atomic weapons since they can depend upon minutiae of atomic-weapon design** which lie outside the scope of this paper. For the purpose of the present discussion, it is sufficient to assume that no two nearly-simultaneous atomic explosions should be planned for aiming points closer together than about two damage-circle diameters, and that a waiting period of about three minutes should elapse before delivery of another atomic weapon of which the damage circle touches or overlaps the damage circle of the preceding weapon.

52. The restrictions imposed by the safety of delivery aircraft and the prevention of fizzles, set up working rules for the planning of multiple atomic-weapon attacks. In essence, these rules suggest that a plan for multiple atomic explosions to blanket an army sector or concentration area should not lead to two nearly simultaneous explosions within adjacent damage circles, but should allow instead for a waiting period of about three minutes between explosions in adjacent damage circles regardless of the method of delivery. Two illustrative examples from the Korean campaign are given in Annex 4 of this Appendix.

TACTICS

General

53. The following discussion is offered to suggest some of the tactics which may be developed to increase the effectiveness of atomic warheads against troop targets.

* See Appendix A, paragraph 12.

** The Effects of Atomic Weapons: p. 16-17.

54. The atomic warhead is a weapon for the massive destruction of area targets. When properly used against such targets, its effectiveness in producing disorganization, casualties, and material damage to ground forces will exceed a thousand sorties by tactical aircraft armed with any other type of weapon.* Furthermore, these results will be achieved for a small fraction of the total dollar-cost of any other type of attack. Primary attributes are suddenness, saturation, and complete coverage of soft targets up to four miles in diameter.

55. The atomic warhead is complementary to conventional weapons.** It cannot be used effectively against infiltrated positions or thin lines in close contact with friendly troops. Other passive defense tactics which tend to minimize its effectiveness include the use of self-contained task forces of less than regimental size; emphasis on mobility, particularly when moving through rear areas or into assembly back of the line of departure; the dispersal of bivouac areas; and maximum use of concealment.

56. The tactics developed by ground commanders, preparatory to the use of atomic warheads against a numerically superior enemy, should be aimed at preventing the enemy's use of passive atomic-defense tactics of the kinds just outlined. That is, the enemy should be forced to use his numerical superiority; the tactics used against him should be planned to make him employ strength in depth, heavy reserve forces, and massive troop concentration.

57. a. The effective tactical use of atomic weapons places a premium on reliable intelligence of enemy positions, concentrations, and movements (see Appendix C).

b. The second critical factor is the total elapsed time between target identification and delivery of atomic attack. This time should be cut to the absolute minimum possible (see Appendix D). In fluid situations it may be necessary to reconnoiter the target shortly before zero time to verify its continued presence. Many targets--reserve troops departing from an assembly area, for example--may dissipate in two to four hours.

Defense of a Position or Line

58. Near the line of battle. a. Once forces are in contact, the nearest aiming point for atomic weapons against attacking enemy forces will generally fall in his artillery

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* See Appendix I

** See especially paragraph 58b.

area or in the area of the rear elements of the front-line forces, since the safety of friendly troops from a 40-KT air burst will require either that actual ground zero be at least 5,500 yards forward of friendly exposed outposts,* or that these outposts be dug-in and forwarned, or withdrawn to a safe distance shortly before zero time. Enemy casualties then would be heaviest in his artillery and service areas and among the rear elements of the front line forces. If his forward infantry elements are advancing or are prone or shallowly entrenched, their casualties also may be comparatively heavy.** If they are deeply entrenched, enemy infantry casualties forward will be comparatively light.

b. In such a situation, the primary weapons against his most forward elements generally will have to be artillery and small arms, unless the defending commander can withdraw his own forward elements unobserved shortly before zero time. In general, the destruction of the enemy rear elements, as an organized force, will cut off and expose the forward elements and should make them very vulnerable to conventional arms.

59. Enemy reserves. a. One of the most lucrative atomic targets is a force of reserve troops massed to exploit an expected breakthrough. Such troops are not likely to be well dug-in before the attack. However, they are likely to reach maximum vulnerability to atomic weapons shortly after the attack on the line gets under way, since they can be expected to leave shelter and move into maximum concentration preparatory to jumping off. An atomic attack delivered at this critical time would produce very heavy casualties and would probably disorganize the enemy to such an extent that the whole breakthrough effort would fail.***

b. The planning of such an atomic attack should provide for not less than one atomic weapon to disorganize and not less than two atomic weapons to neutralize a reserve division of NKA or CCF size.

60. Reserves in bivouac often present excellent targets of opportunity, provided they can be located and identified. An atomic-weapon burst over such a spotted bivouac area during the day or, preferably, shortly after dark in the case of CCF, could inflict severe damage to personnel and materiel. Dispersal to minimize casualties to this type of target might be expected after a few attacks. Dispersal would restrict

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* See paragraphs 16-35.

** See Annex 3, Defense of a Perimeter.

*** See Annex 1, Appendix C, the CCF Attack on Line Baker as an example.

the enemy's freedom of movement and hamper his command and political control of his troops.

61. Enemy penetrations in force. Penetrations in strengths above regimental size may be defeated with atomic weapons. This operation would require care in coordination and timing. Containing forces would have to be used against the head of the column only, since they would be within atomic-weapon range if attacking the column on the flanks. Ground zero would be located near the center of strength in the column, say about 5,000 yards back of the leading elements.

Offensive Ground Operations

62. Breakthrough. Breakthrough operations supported by atomic weapons would be organized and exploited somewhat differently than would the same maneuver with conventional weapons. The following procedures might be used.

a. Preparation. Outpost and forward elements would be pulled back into the MLR shortly before zero time. The abandoned ground would be covered by HMG, mortar, or light-artillery fires, if necessary to keep the enemy from moving up. One or more lines of ground zeroes for the atomic attack would be laid out at least 5,500 yards from friendly MLR (assuming a 40-KT weapon), and covering enemy's MLR and artillery positions. There would be no requirement for concentrated area artillery fires or carpet bombing, since this role would be taken over by two or more atomic weapons spaced about 6,000 yards apart along enemy's MLR (assuming a Class B target*).

b. Attack. Infantry jump-off time from friendly MLR might take place 10 to 30 seconds after the last atomic air burst and could expect to meet negligible opposition in mopping up remaining enemy forces in the gap. Counter battery- or support-fire by own artillery would be directed, as necessary, against any remaining enemy outposts or enemy positions on the flanks of the breakthrough.

c. Exploitation. Mechanized forces from reserve areas would arrive in times of march planned to bring them into the breakthrough gap shortly after zero time. They would pass through the forward infantry forces, roll up the flanks of the breakthrough and penetrate to the rear. Atomic attacks would be used to neutralize any enemy reserves within effective march of the breakthrough.

63. Placed charges in offensive operations, including guerrilla warfare and sabotage. All atomic warheads can be

* See paragraphs 84 and 104, Appendix A.

placed as mines on-ground or under the surface by ground parties, to accomplish major demolitions. These may be placed by advance parties to neutralize an area preparatory to advance of the main forces. They form an effective sabotage instrument for use by guerrillas, and airborne or infiltrated troops, to accomplish major destruction and weakening of positions behind enemy lines. Methods of time-delay fuzing are possible to permit retirement of the ground parties or guerrila bands. Coordination of such activity with offensive action by friendly forces can be extremely effective in disrupting and destroying a defending position and defending forces. Annex 2 of this Appendix also discusses an example wherein shallow underground brusts of atomic weapons, either placed by hand or delivered by dive bombing, can be used against defiles along a supply route, to effectively interdict the MSR or block a line of retreat.

64. Other offensive operations. Other offensive operations, such as neutralization of an area preparatory to establishing a bridgehead, elimination of major pockets of resistance, and pursuit, could be supported by atomic weapons in ways which are reasonably obvious.

Disengagement and Withdrawal

65. Disengagement and withdrawal may be difficult to accomplish* if the opposing forces are large or if enemy pressure is heavy. If atomic warheads are used by the withdrawing forces to effect disengagement under pressure, the following sequence might be used.

a. MLR. The main line of resistance should be prepared and held in sufficient strength to force the enemy to redeploy and mass his strength against it.

b. Atomic strikes against attacking forces. The first atomic attacks would be delivered against the enemy's front line troops in a manner similar to that outlined previously under the heading Defense of a Line (paragraphs 58-61).

c. Atomic strikes against enemy reserves. Enemy reserves within effective march of friendly MLR should be located and disorganized by atomic strikes against them.

d. Atomic strikes against enemy MSR. The withdrawing forces would deliver atomic strikes against enemy MSR.

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* Generally not applicable to NKA and CCF, whose rate of movement is slow compared with mechanized UN Forces in Korea. Possibly even more important is the absence of any NKA or CCF Tac Air forces to hamper withdrawal.

They also would bury short-time fuzed atomic charges in their rear to discourage and disorganize pursuit by the enemy. These underground bursts would produce major craters and radioactive-contamination hazards to block or re-channel the direction of pursuit.

Neutralization of Large and Very Large Areas

66. The tactics discussed thus far have been based on the selection of one to several separate target areas for attack by atomic bombs. This weapon also may be used to deliver massive attacks on areas of a hundred square miles or more.

67. For example, suppose that five CCF armies (organization strength 38,500 men per army and actual strength about 30,000 men per army) are known to be located in an area of 200 square miles. An effective carpet-bombing attack against such a target with conventional weapons would not be feasible,* first, because the number of sorties required would exceed the availability of bombers, and second, because a target of this nature probably would be too diffuse for profitable attack. In contrast, it can be shown that a target of this large and diffuse nature can by attacked profitably with atomic bombs and that the delivery of such an attack would require only about a dozen sorties.

68. For definitiveness in discussion, it will be assumed that intelligence sources, topographical features, and available cover indicate that the above 150,000 troops are within an area of not more than 240 square miles nor less than 180 square miles and that the more probable area is 200 square miles. It also will be assumed that there are no large troop concentrations which can be singled out for pin-point attacks. That is, the troops will be assumed to be randomly and diffusely distributed as small organizational groups in light cover within the target area. Three questions then may be asked:

a. What is the approximate maximum number of 40-KT bombs required to produce at least 50 percent casualties in the area?

b. What is the minimum number required to produce at least 30 percent casualties?

c. What is the minimum number required to produce 40 to 50 percent casualties?

69. The maximum number of bombs required to produce 50

* See Appendix I for a more detailed discussion.

percent or more casualties obviously would be based on the assumption that the troops occupy the largest area of 240 square miles. The total target area then would be about 750 million square yards and the average troop density would be 200 men per million square yards. The plan of attack would be made by laying out a succession of aiming points on a map of the area so as to cover the area with target circles, each of about 6,000 yards diameter and 30 million square yards area.* This procedure then would indicate 25 aiming points (25 times 30 million square yards equals 750 million square yards) and hence would require 25 bombs. The expected casualties per bomb can be determined by reference to Figure 3 of Annex 1 in this Appendix. For a troop density of 200 per million square yards and target diameters of 6,000 yards, the average expected casualties per 40-KT bomb are 3,600, giving a total casualty expectation of 90,000 for 25 bombs or 60 percent of the troops in the area.

70. The minimum number of bombs to produce 30 percent casualties would be determined by laying out aiming points 8,000 yards apart to cover the smaller area of 180 square miles (560 million square yards) with target circles, each 8,000 yards in diameter and 50 million square yards in area. The number of bombs required then would be 11. If all 150,000 troops actually were in the 560-million-square-yard area, the troop density would be about 270 per million square yards and the expected casualties would be 5,400 per bomb, giving total casualties of 59,000 from 11 bombs. However, the troops actually might be occupying the entire area of 240 square miles, giving an average troop density of only 200 per square mile, and 4,000 casualties per bomb. In this case, the total expected casualties would be 44,000 instead of 59,000; i.e., 29 percent instead of 39 percent enemy casualties.

71. The intermediate number of bombs to produce 40 to 50 percent casualties would be spaced about 7,000 yards apart (target circles of 40 million square yards) to cover the more probable target area of 200 square miles, (total area 620 million square yards; average troop density, 240 per million square yards). This plan would require 15 bombs. The expected casualties would be 4,800 per bomb and the total expected casualties would be 72,000 for a troop density of 240 men per million square yards. Here again, however, the troops might be distributed over the whole area of 240 square miles, so that the expected casualties would be 4,000 per bomb or 60,000 total expected casualties. The above numbers then correspond to a minimum of 40 percent casualties and a maximum of 48 percent for a 15-bomb attack on the area.

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* See paragraphs 57-61 and particularly Figure 10 of Appendix A. See also Annex 4 of this Appendix.

72. The preceding analysis indicates that future major tactics may include the systematic neutralization of entire fronts by massive attacks delivered in one to two hours with atomic weapons. Since the conditions assumed in the preceding analysis presuppose nominal cover, it follows that even diffuse troop deployments in rear areas must be dug-in for protection when the threat of massive atomic attack is present.

CHARACTERISTICS OF CCF TACTICS IN KOREA INFLUENCING TACTICAL EMPLOYMENT OF ATOMIC WEAPONS*

73. CCF holding a position against UN forces, or in attack, are able to bring heavy forces to bear within a few hours. Therefore they must be assembled, at times, in dense concentration in order to accomplish this. In the general movement toward an area of engagement, CCF columns appear to advance by the easiest avenues of approach and the most negotiable--the MSR's, the feeder roads, stream beds and valleys. There is no stealth in the approach; they come in erect, sometimes walking, sometimes at a slow run; they often use bugles and whistles for signaling and for psychological effect. They frequently stop to loot and pillage during the course of the attack. In the attack, they seldom come over and down the ridges, but move around hill bases and through the draws. This pattern seems to be almost invariable.

74. Enemy main forces usually attack at night, frequently taking advantage of periods before moonrise** and when held or repulsed, withdraw just prior to dawn. During the day they probably concentrate either in villages or under cover. The systematic use of village cover seems to be standard procedure with the CCF; they take refuge in the native huts in numbers which would be unthinkable to any western force. They concentrate their field forces in this manner during daylight hours, using village concealment adjacent to their line of advance and main object of attack, chiefly because there is no other place to hide, except in caves or heavily forested areas. Whole armies cannot hide themselves in man-made works and yet escape detection by normal use of air reconnaissance, despite their consummate skill in camouflage. Likewise, they cannot deploy on ridgelines or among hilltops and remain capable of reassembly within a small enough interval of time to permit them to achieve effective concentrations against a mobile opponent. To deny these

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* Drawn largely from ORO-T-7 (EUSAK), Infantry Tactics in Korea, and ORO-T-8, (EUSAK), North Korean Logistics and Methods of Accomplishment.

** See Appendix C, Annex 1. The attack on Line B (Imjin) on 31 December 1950, began before midnight. Moonrise occurred just after midnight.

forces any use of village concealment or natural cover by burning them out or putting them under light at night would reduce the effectiveness of such furtive tactics and be an essential step toward the disruption and paralysis of their operations. Thrown upon the open countryside, they would lose effective mobility in any season.

75. When CCF tactical forces harbor in wooded regions they sometimes cut the trees halfway up the trunk and bend the upper portion over so as to give themselves greater concealment.

76. CCF forces often attack UN forces diagonally to the MSR from flanking heights. Trails from the hills, subsidiary stream beds and gulches very often lead into the UN MSR diagonally. Hence the most probable location of their main forces in any local action may be in the flanking heights to the UN MSR just behind their holding forces. These main forces will generally be under cover, but not dug-in or under any appreciable physical protection against bombing. Friendly air has not been able effectively to located CCF in force along the opposing MSR or elsewhere.*

77. CCF are almost invariably committed to an attack on one line, with no options. This holds true of divisions, as of battalion and company formations. Each unit is usually given one set task. Each appears to persist in this task as long as any cohesive fighting strength remains. When beaten back, CCF appear planless and aimless, incapable of rallying toward some alternative objective. Troops withdraw and sit on the countryside.

78. Illumination of any kind placed on the CCF front line forces produces disturbances bordering on panic, and frequently forces recoil. Defensive wire in any form likewise confuses and disturbs them and they invariably stop and try to crawl under it or over it, thus exposing themselves and suffering heavy casualties. Following waves of CCF troops may then pass through over the bodies.

79. Air strikes apparently produce a noticeable and immediate shock to morale of CCF defenders even though the damage from the bombing and strafing may not be high. Enemy fire from positions under such attack may go silent for periods varying between 10-20 minutes, depending upon the extent of damage and disarrangement done.

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* See Appendix C, Annex 4 for details of an aerial method for locating and evaluating personnel targets. See also paragraph 83 of this Appendix.

80. CCF patrols are adept at probing UN defenses, moving swiftly from one point to another, to find the weak point in the defense. Rather than attempt a frontal attack on a defensive point, penetrations are usually made between two front-line units, where a gap has been discovered or created, and forces are poured through in large numbers to exploit the opening. On the night of 31 December 1950, after considerable probing by patrols, sometimes in company strength, a gap between the 11th and 12th ROK Regiments of I Corps on Line B (Imjin) was entered and penetrated. CCF troops poured through in about Division strength about two hours before midnight,* proceeded quickly to disperse the defender's flanking forces, and in a short time forced UN withdrawal to a new line.

81. Analysis of tactics and terrain, and patrol and holding-force operations in the field, can lead to predictions of the probable location, at a specific time, of enemy troop concentrations. Support must actively be given to this by extensive use of photo reconnaissance and immediate and expert photo interpretation.

82. Dispersal rather than any special techniques of furtive tactics is the method mainly used by the CCF to avoid detection and damage from the air. Small groups scatter, and pull rice sacks or straw over them; hence they blend into the surrounding terrain. At the speeds and heights at which UN attacking planes and photo-reconnaissance planes have invariably flown,** such targets have been almost impossible to detect.

83. However, visual observations from low-flying, slow Mosquito planes show that the distribution of CCF troops is not abnormal near the line of battle. Figure 1 shows the distribution of CCF troop targets*** sighted during the period 18-24 November 1950 before firm contact with UN forces. Figure 2 shows the distribution for 25-27 November when firm to heavy contact was first established.

84. The above discussion of CCF tactics indicates a considerable degree of success on the part of the enemy in overcoming his deficiencies in equipment, logistics, and weapons. It also indicates his vulnerability to atomic attack.

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* See Appendix C, Annex 1.

** See Appendix C, Annex 4 for a discussion of needed improvements in photo reconnaissance, including increases in vertical scale.

*** Data from ORO-R-3, Appendix B, Annex 3, "Analysis of Targets Available, Based on Mosquito Records."

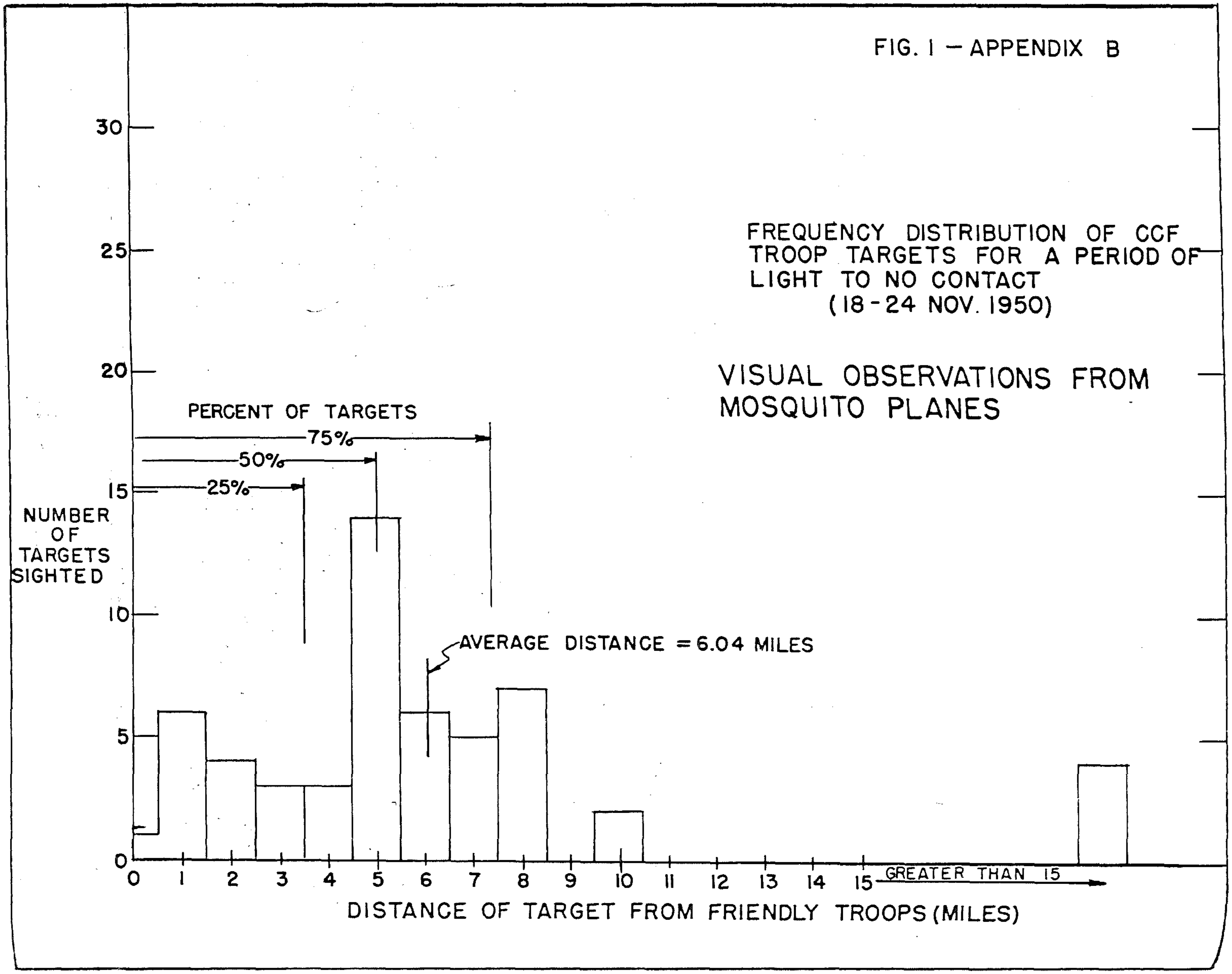
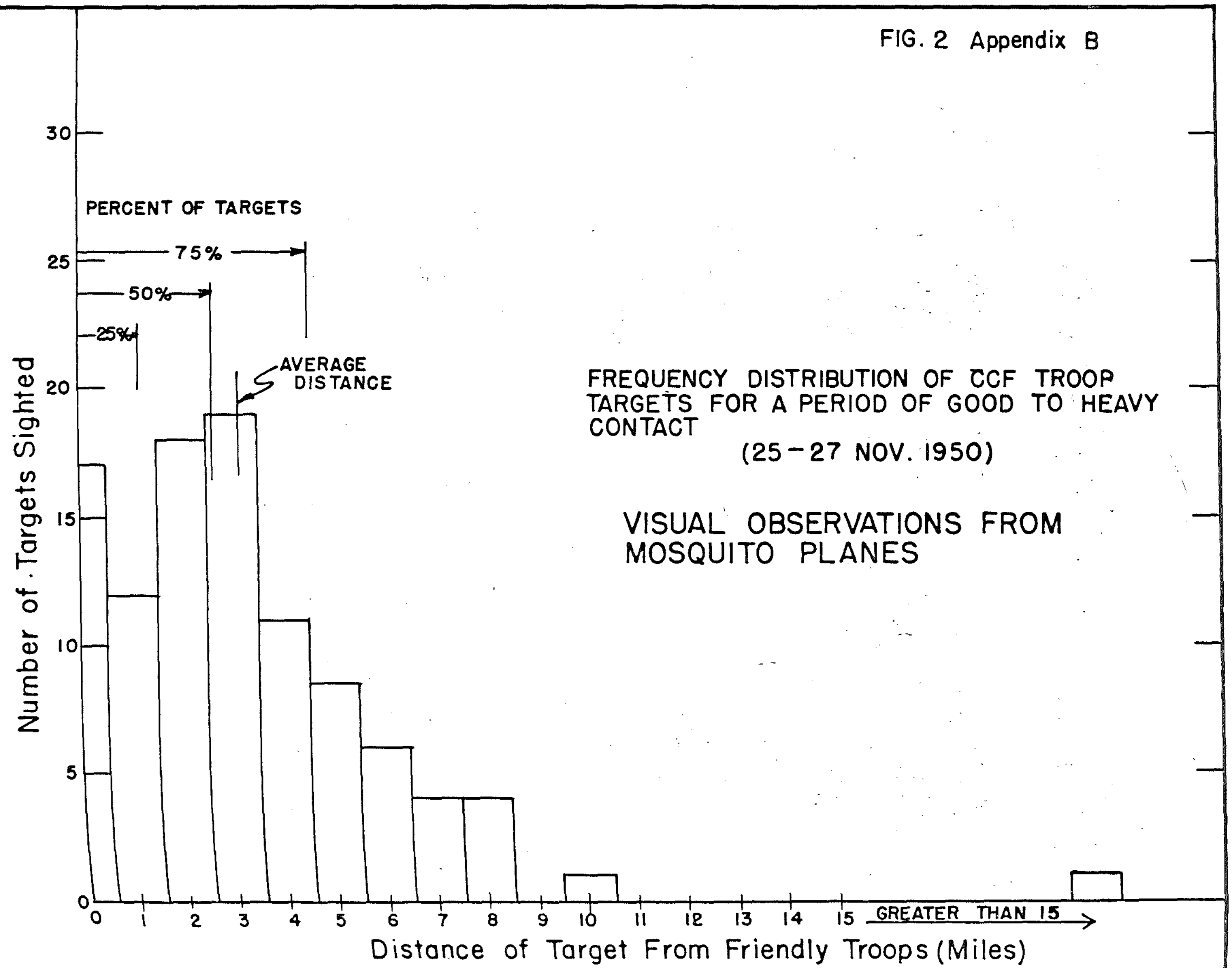


FIG. 1 — APPENDIX B
FREQUENCY DISTRIBUTION OF CCF TROOP TARGETS FOR A PERIOD OF LIGHT TO NO CONTACT (18-24 NOV. 1950)
VISUAL OBSERVATIONS FROM MOSQUITO PLANES
PERCENT OF TARGETS
75%
50%
25%
AVERAGE DISTANCE = 6.04 MILES
NUMBER OF TARGETS SIGHTED
0
5
10
15
20
25
30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
GREATER THAN 15
DISTANCE OF TARGET FROM FRIENDLY TROOPS (MILES)

FIG. 2 Appendix B



EXAMPLES OF POSSIBLE TACTICAL APPLICATIONS OF ATOMIC WEAPONS IN KOREA

~~Atomic Weapons in Korea~~

85. Examples of possible tactical applications of atomic weapons in Korea are more fully described in other sections of this report as follows:

a. Interdiction of a supply route. Annex 2 of this Appendix describes the expected results from the shallow underground burst of a 20-KT weapon. It shows how this single burst, if accurately placed, can completely interdict the MSR on the Nomdae-Chon defile for a long period of time by the great physical havoc it produces, at the same time preventing effective repairs by virtue of severe radioactive contamination of the area.

b. Perimeter defense. Annex 3 of this Appendix describes methods for defensive action using atomic weapons, with the Pusan perimeter as an example. Several situations are discussed emphasizing safety to friendly troops as a criterion. In a withdrawal it would be possible to effect these tactics under cover of the resulting enemy disorganization. The situation is an assumed one.

c. Attack on a stabilized line. Annex 1 of Appendix C describes the vulnerability of CCF and NKA deployed against the stabilized line B (Imjin River) 17-31 December 1950. The situation represents build-up of enemy forces to sufficient strength for attack. On 31 December, just before the attack, concentrations were high enough to present very lucrative targets for atomic weapons.

d. Taechon, Korea, as a probable target. Annex 2 of Appendix C discusses the expected effect of one 40 KT atomic air-burst on the CCF 66th Army (Corps) presumed to have been in the neighborhood of Taechon, Korea, on the night of 25-26 November 1950. The attack would probably have produced 15,000 casualties out of a total of 28,000 troops, with resultant disorganization and neutralization of the CCF 66th Army.

e. Location of targets from daily intelligence summaries. Annex 3 of Appendix C represents results of search of Daily Intelligence Summaries for enemy targets that would be lucrative for atomic-weapon attacks. In general, troop densities as presently reported by intelligence seem too small to represent worthwhile targets. However, it may be that these low densities are not real but are the result of restricted intelligence.

f. Multiple delivery of atomic weapons. Annex 4 of Appendix B discusses requirements for timing and sequential delivery, in an atomic attack on large targets which require more than one atomic weapon for decisive results. The enemy disposition of 67,000 CCF troops on 27-29 December 1950 in the Chorwon-Kumhwa-Pyonggang triangle, and of 18,000 CCF-NKA troops in the Wonju bowl on 7-8 January 1951 are cited as examples.

g. Target of opportunity. Annex 1 of Appendix D discusses time factors in the development and recognition of a target of opportunity and the subsequent operational action. The need for a joint intelligence-operations process is stressed. The particular example chosen is the discovery of an enemy regiment northeast of Chipyong-ni on ground above the Hukchon River at 0900 on 10 February, and carries the action through to 1940 on the same night, when air support reported results.

APPENDIX B, ANNEX 1

TARGET EVALUATION AND INTELLIGENCE REQUIREMENTS

1. In Appendix A, weapon effects have been discussed in detail, including percentage casualties to troops in various situations as functions of distance from ground zero and of burst height.

Nature of Errors

2. A study has been made of the effect when errors, σ_i, introduced as the result of inaccuracies in intelligence information concerning the location of a target-center, are added to errors in delivery of the weapon, σ_d. The square of the probable error is $\Sigma^2 = \sigma_i^2 + \sigma_d^2$.

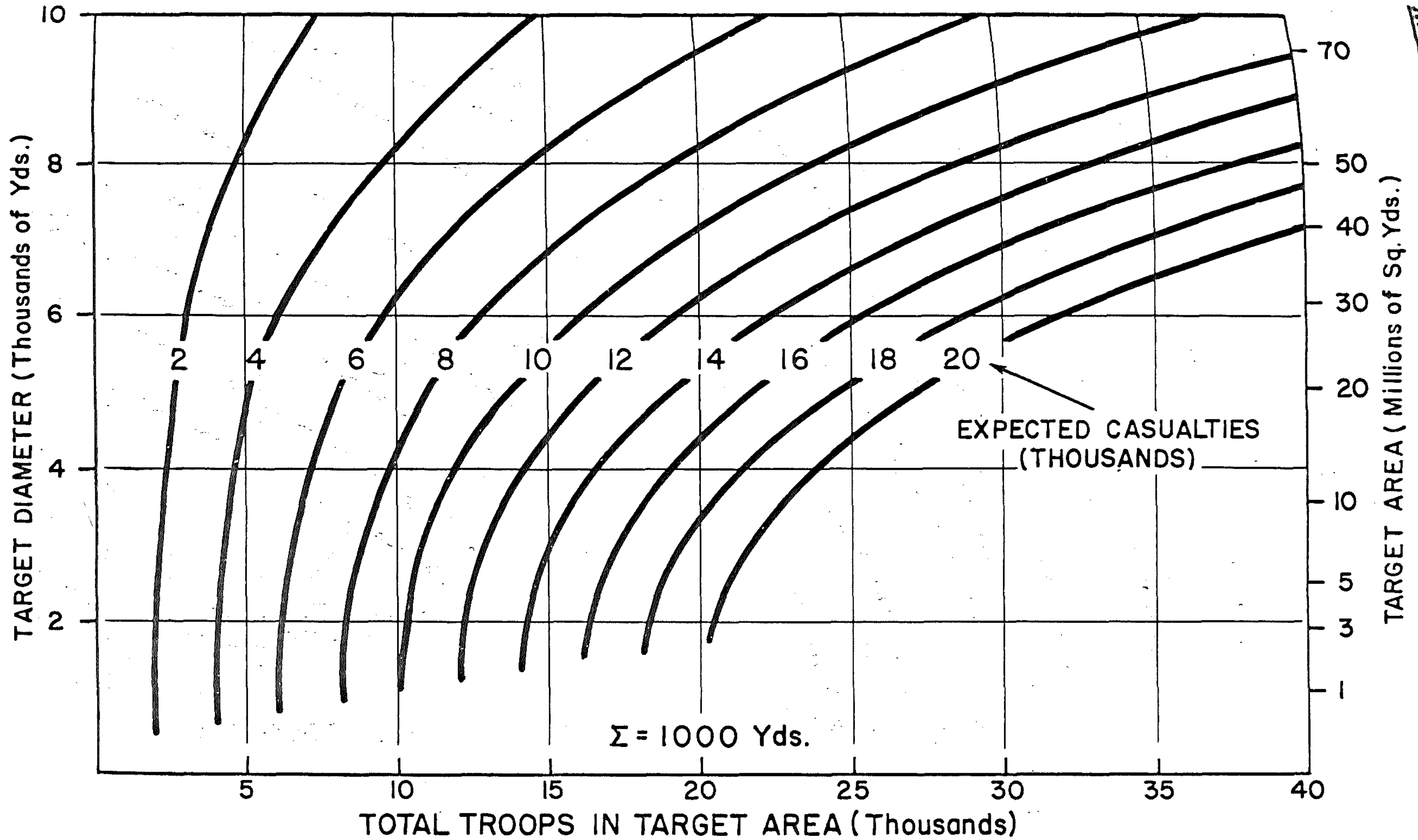
3. Two cases are considered:

a. An area target with troops uniformly deployed over the area.

b. A line target with troops uniformly deployed along the line. (This is also applicable to a long target of shallow depth.)

4. Figure 1 gives the total number of troops in target areas of various sizes, required to yield given numbers of casualties when $\Sigma = 1{,}000$ yards. It is applicable to troops in Class B targets as defined in Appendix A, paragraph 84b. For example, to receive 10,000 casualties per bomb in a circular target of 6,000 yards diameter within which troop deployment is uniform, 16,000 troops must be within the area (28×10^6 sq yd).

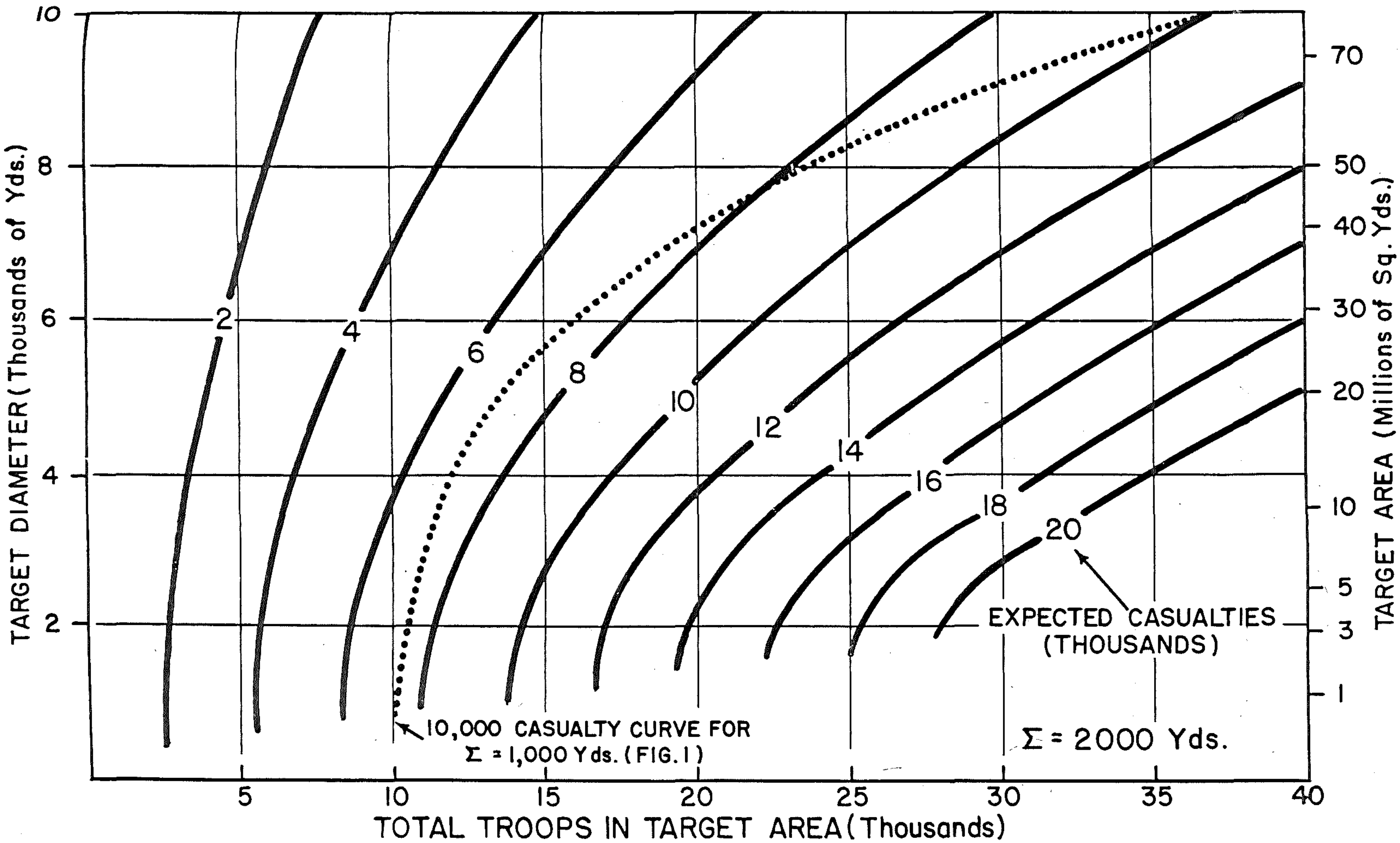
5. Figure 2 gives similar representative curves when $\Sigma = 2{,}000$ yards and compares them with a curve (dotted) from Figure 1. It will be noted that larger troop concentrations are required to produce the same number of casualties for larger Σ when the area is small, but for areas in excess of 10,000 yards diameter, the concentrations required approach the same value.



Total number of troops per million square yards required to obtain various casualties expressed as a function of diameter of target.

Conditions:
- (a) 40 KT atomic bomb.
- (b) Visibility 6 miles.
- (c) Height of burst 3,500 feet.
- (d) Men in open (Class B target, Appendix A, Table XII).

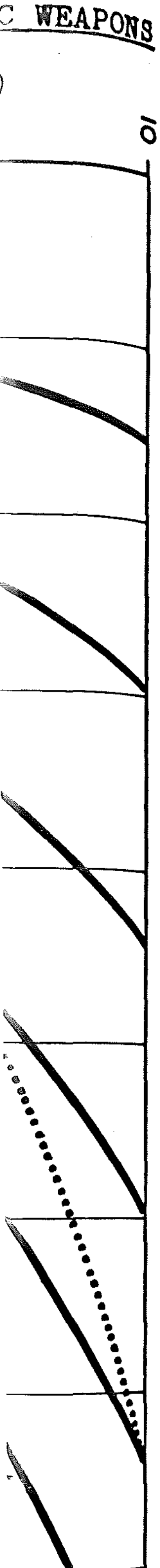
FIG. 1
APPENDIX B
ANNEX I



Total number of troops per million square yards required to obtain various casualties expressed as a function of diameter of target.

Conditions:
- (a) 40 KT atomic bomb.
- (b) Visibility 6 miles.
- (c) Height of burst 3,500 feet.
- (d) Men in open (Class B target, Appendix A, Table XII).

FIG. 2
APPENDIX B
ANNEX I



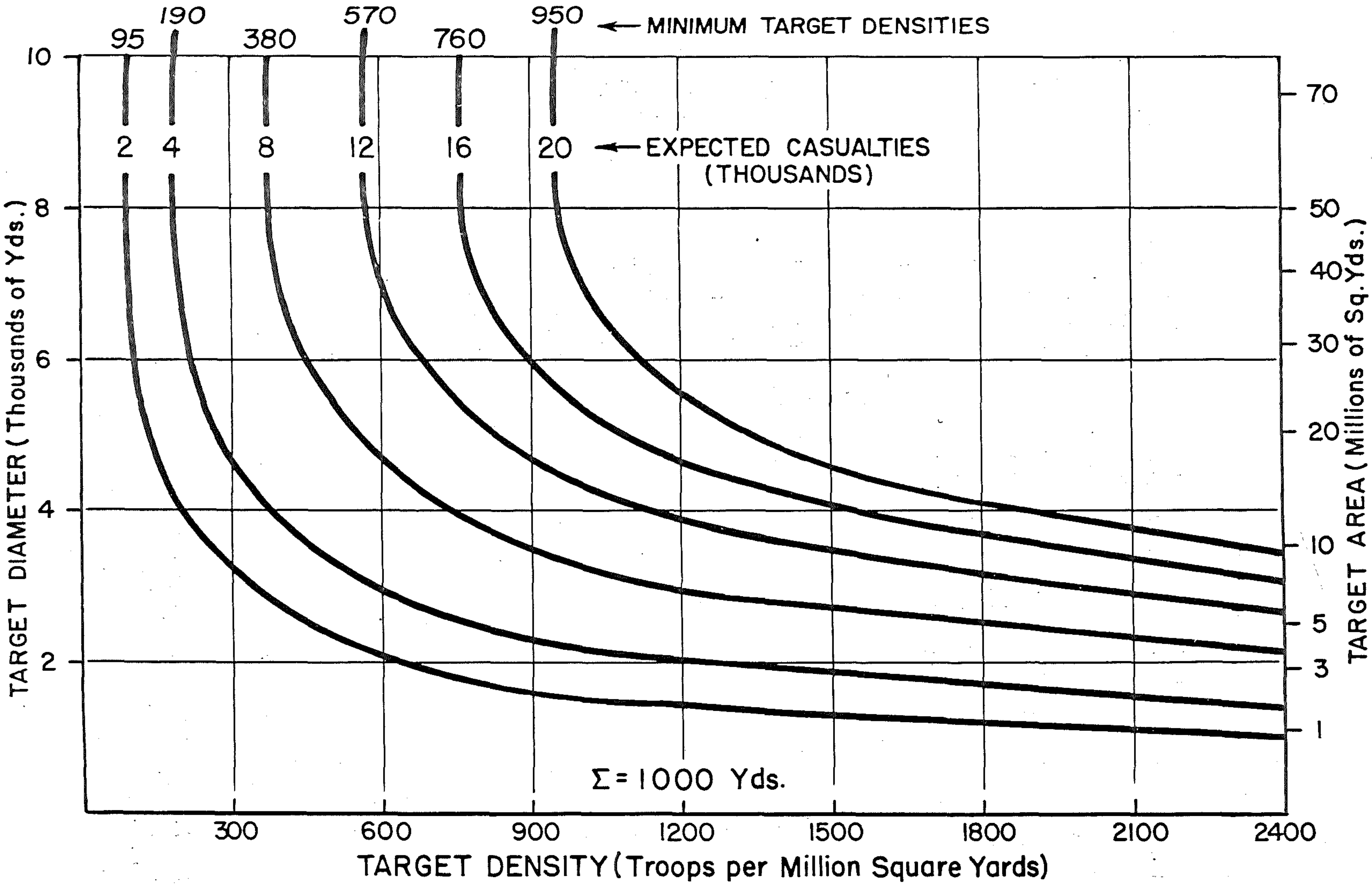
6. Figure 3 presents the data of Figure 1 in terms of number of troops per million square yards. It demonstrates that a minimum of 48 troops per million square yards is required to produce one thousand casualties per bomb whenever the target diameter exceeds 10,000 yards. (Large areas may be treated as approximately circular.) For larger required casualties (N), the minimum concentration is 48N/1,000 troops per million square yards.

7. Figure 4 presents data for line targets, showing the number of troops per thousand yards of line required to produce one thousand casualties per bomb, along lines of various lengths. It may be seen that a minimum of 195 men per thousand yards is required whenever the length of the line exceeds 10,000 yards if the troops are in the open, and a minimum of 260 men per thousand yards is required when the Σ is greater. For larger casualty requirements (N), multiply the minima just mentioned by N/1,000.

8. The figures demonstrate quite clearly that when an area target exceeds 10,000 yards diameter, or a line target exceeds 10,000 yards in length, Σ need not be less than 2,000 yards. Assuming that bomb inaccuracies give a CPE of 500 yards, this means that the intelligence probable error, σ_1, can be practically 2,000 yards if the target is 10,000 yards in diameter, 3,000 yards if the target is 12,000 yards in diameter, 4,000 yards if the target is 14,000 yards in diameter, and so on. That is, the allowable probable error in intelligence, σ_1, is approximately $\sigma_1 = (D-6000)/2$ yards, for target diameters, <u>D</u>, of 10,000 yards or more.

Application of the Method

9. The results just given may be applied to the case of the 66th Chinese Communist Army at Taechon (Appendix C, Annex 2), as an illustration. Treating this Army as an area target of 25 million square yards with 21,500 troops, yields 14,500 casualties for $\Sigma = 1,000$ yards. If $\Sigma = 2,000$ yards is chosen, the yield is only 11,500 troops. It is to be noted that in Annex 2, Appendix C, the analysis was based on a ground zero close to the center of the target and yielded about 15,000 casualties. The present analysis shows that an error in ground zero of 1,000 yards would have made practically no difference in total casualties.



Number of troops per million square yards required to obtain various casualties expressed as a function of diameter of target.

Conditions: (a) 40 KT atomic bomb.
(b) Visibility 6 miles.
(c) Height of burst 3,500 feet.
(d) Men in open (Class B target, Appendix A, Table XII).

FIG. 3
APPENDIX B
ANNEX I

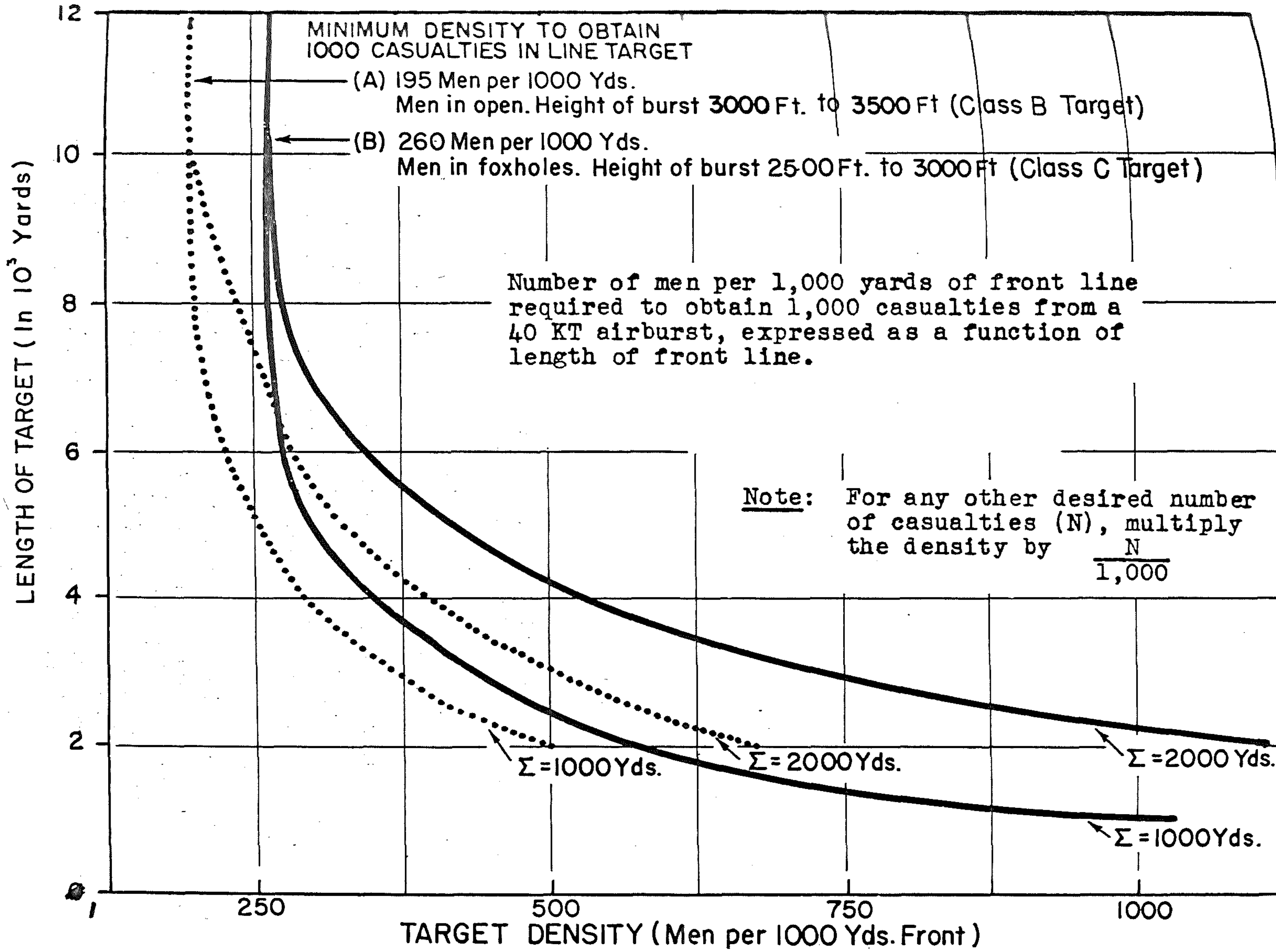


FIG. 4
APPENDIX B
ANNEX I

APPENDIX B, ANNEX 2

INTERDICTION OF A SUPPLY ROUTE

(TERRAIN AND WEAPON REQUIREMENTS)

1. The use of atomic explosions to block passes has been advocated. There are two misconceptions generally prevalent, however, which must be dissipated before this use can be properly considered.

a. The first is that an air burst can be effectual in producing disturbance of the earth sufficient to achieve the desired earth and rock movement, whereas actually an air burst produces only superficial earth disturbance.

b. The second is the popular idea that a pass ordinarily represents a defile, whereas in Korea it is usually a low passage across a sharp ridge which cannot be blocked.

2. If, however, the pass approaches are examined, defiles can often be found with steep, high walls which can be effectively blocked by shallow underground bursts of atomic weapons, delivered by dive bombing or planted as mines, these methods being the only ways to achieve the required accuracy.

3. An example which has been selected to illustrate the procedure is the Namdae-Chon route in the vicinity of Song-sambong (52SCT584866) on the 1,000-meter universal transverse mercator grid. At this point, the Keigen main-line railroad enters a tunnel.

4. Figure 1 (A) shows the profile along a line extending southeast from the point (575872) for 2,300 yards to the point (592861). Figure 1 (B) shows the expected profile after detonating a 20 KT atomic warhead about 50 feet below the surface at position 1000M on the profile. The effect is to wipe out the tunnel entrance, and probably the entire tunnel, to disturb very seriously the course of the river, to produce ground breakup for about 1,000 yards in all directions, and to create a situation in which unknown amounts of radioactive material will contaminate a critical area.

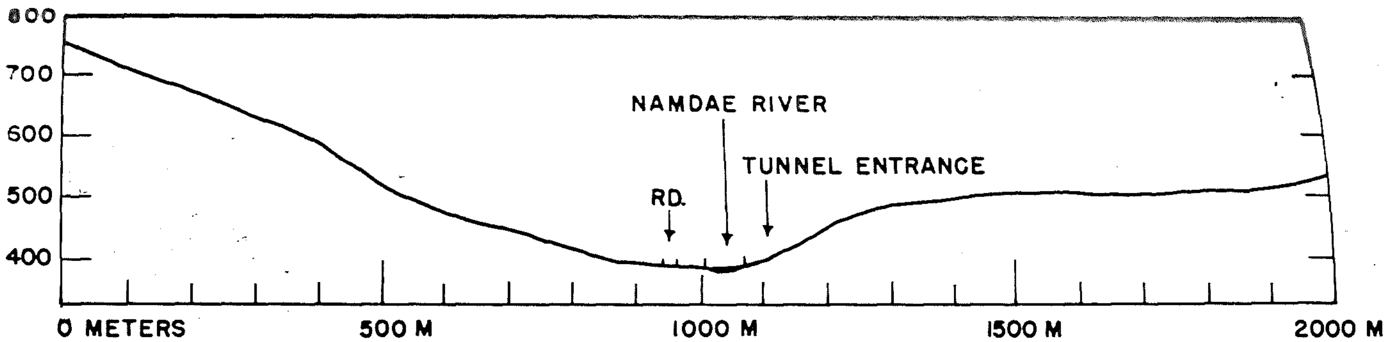


FIG I (A)
PROFILE OF NAMDAE-CHON ROUTE NORTH OF SONGSAMBONG

APPENDIX B (ANNEX 2)

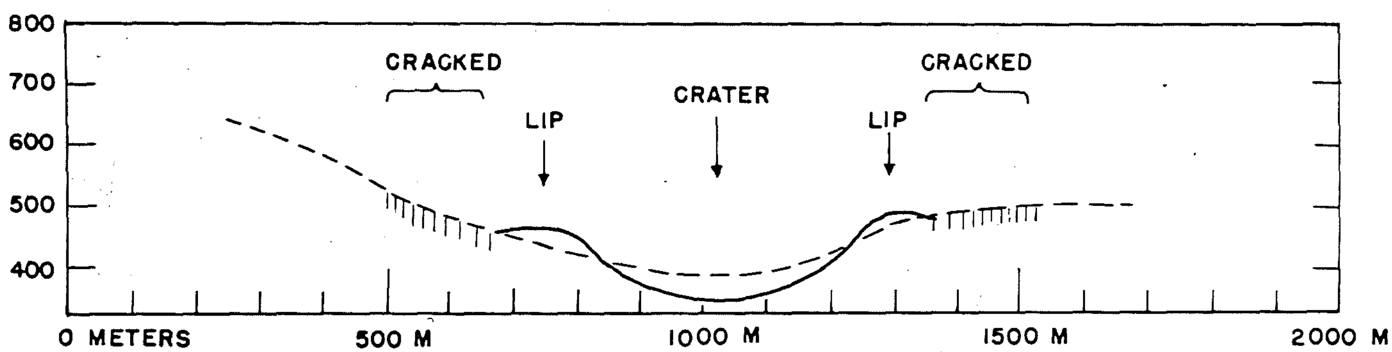


FIG I (B)
PROFILE OF NAMDAE-CHON ROUTE NORTH OF SONGSAMBONG
AFTER UNDERGROUND EXPLOSION OF 20 KT ATOMIC WARHEAD

APPENDIX B, ANNEX 3

DEFENSE OF A PERIMETER

Stabilized Situation

1. Much of the preceding discussion of tactical atomic bombing has been directed toward possible employment against targets of opportunity. In such use exact and rapid intelligence is a crucial factor. Speed of decision and execution are also vital to placing the bomb on the target before the opportunity is lost. (See Appendices C, D, and F.)

2. There are more stabilized conditions, however, which permit carefully planned use of atomic weapons. Typical of such stabilized situations is the complex of actions and counteractions associated with attack upon and maintenance of a defensive perimeter. A perimeter line, with secure flanks and defended in force, would require a substantial concentration of enemy troops first to contain and then to penetrate the position.

Disposition of Forces: Hypothetical Example

3. a. UN forces, estimated at 14 effective divisions, presumably have the capability of establishing a perimeter defense about the port of Pusan along a line approximately 50 miles in length. Such a situation might require 10 divisions in the line and 4 in reserve.

b. Estimating 30 divisions as his strength, the enemy might place 12 divisions on the line with 18 divisions in undetermined locations in the rear. After a short period of line contact it would be normal for UN intelligence to have identified in number, designation, and general location, the 12 enemy divisions in contact.*

4. With 12 enemy divisions on the line in an average depth of 1.5 miles, use of atomic weapons may be planned to permit UN forces to withdraw from the perimeter (and the

* See Appendix C, Annex 1, as an example.

general area, if necessary). Various limitations in this type of line action must be analyzed, however, before any realistic assumptions of bomb capabilities may be made.

Basis of Computations

5. In Appendix A the characteristics of atomic weapons have been discussed, and some representative effects and limitations described as functions of height of burst, meteorological conditions, terrain, and distances from ground zero and aiming point. In Appendix B are discussed safe distances from friendly troops, and the tactics and organization required for the employment of atomic bombs in support of ground operations. The information described in these two appendices will be used in the following two situations and their variations, to analyze the possible use of 40-KT atomic weapons in a perimeter defense. A CPE of 500-yards radius to allow for weapon delivery errors will be assumed throughout this discussion.

Two Situations

First Situation;- First Variation:

Aiming Point 6,500 Yards from Friendly Troop Line (Men in Open)

6. a. Figure 1 presents the effects on front-line troops, in the open, of exploding a 40-KT atomic weapon at 3,500 feet, on a clear day with visibility of 12 miles, over a point 6,500 yards behind the enemy front line.

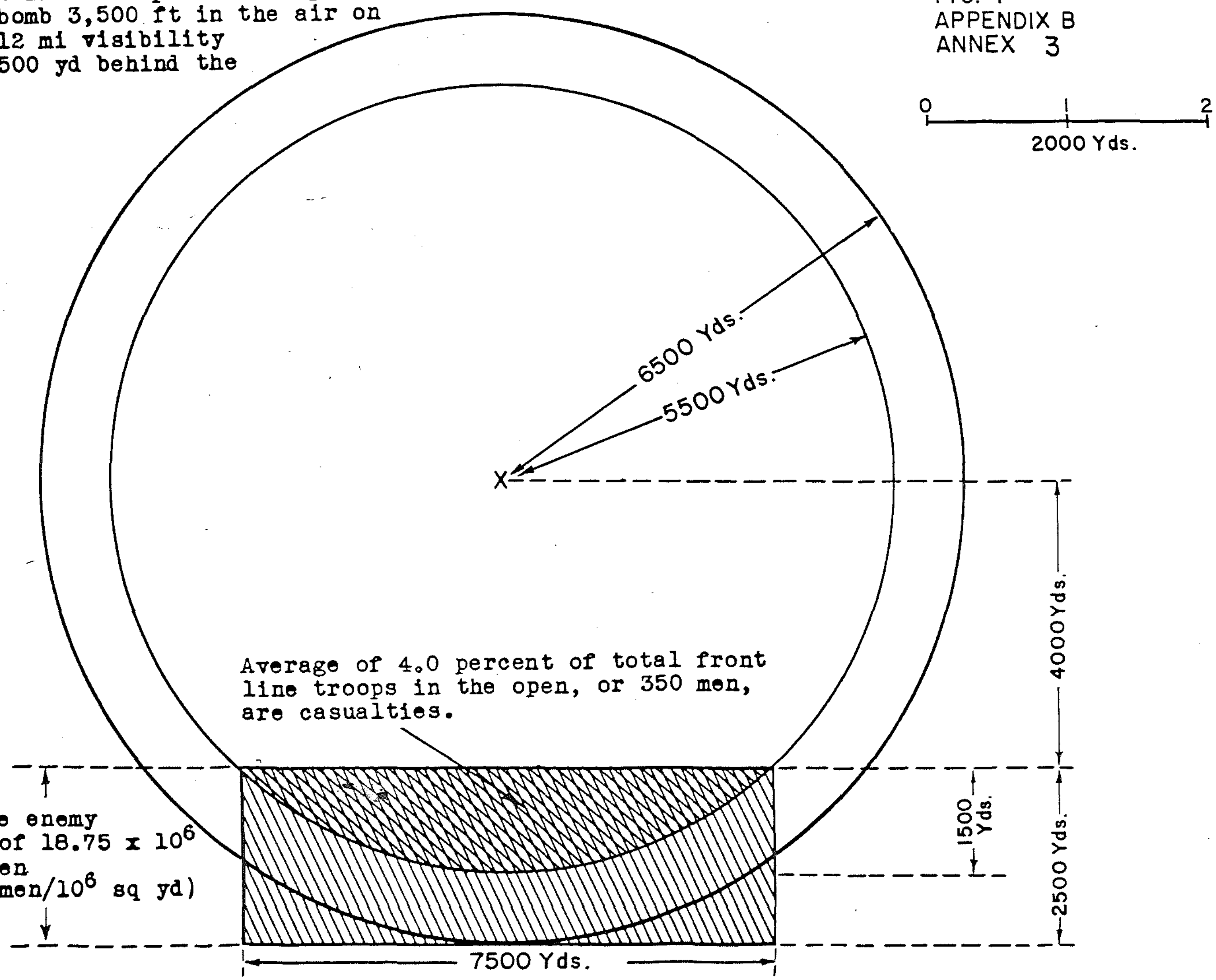
b. From Appendix B the limit of friendly personnel damage from the physical effects of the bomb is 5,500 yards from ground zero. Adding 1,000 yards, or twice the CPE of 500 yards radius to allow for errors in delivery, makes the aiming point 6,500 yards from the troop line.

c. Figure 1 then presents an estimate of the number of casualties among the enemy forces deployed uniformly along a 50-mile line to a depth of about 1.5 miles or 2,500 yards. The number of enemy troops within the region of interest, which is an area 7,500 yards long by 2,500 yards deep (or 18.75×10^6 square yards) totals 9,375. About 3,700 of these enemy troops, in the region within the 5,500 yard circle, will be affected by one bomb. These numbers are based on 12 divisions, 9,000 men per division, giving a density of about 1,500 men per square mile or 500 men per million square yards.

7. a. In this vulnerable area about 350 men will become

FIG. 1
APPENDIX B
ANNEX 3

Effects on front line troops in the open of exploding a 40 KT atomic bomb 3,500 ft in the air on a clear day of 12 mi visibility over a point 6,500 yd behind the front line.



Total front line enemy troops in area of 18.75×10^6 Sq yd = 9,375 men (density = 500 men/10^6 sq yd) casualties from the effects of the bomb. Hence, it is seen that only 350 men or about 4 percent of 9,375 men in the open in the front-line area will become casualties from a weapon the aiming point of which is 6,500 yards from the friendly forces. The danger to friendly troops on the front line in this situation is essentially zero. (See Tables III and V, Appendix B.)

b. The meager results of such use of atomic bombs against front-line forces under such conditions emphasizes the necessity for bringing the aiming point much closer to the front line.

8. Enemy reserves, assumed to be about 18 divisions and deployed roughly four miles to the rear of the front-line forces, may be affected materially by using an aiming point 6,500 yards from friendly front lines. However, inadequacies of intelligence as to locations, strengths and deployments defeat any attempt to evaluate theoretically the resulting damage against such forces. In the situations studied here, the front-line forces opposing the perimeter line are presumed to be the primary target.

9. Under the conditions described, the atomic weapon would be ineffective as an aid to perimeter defense.

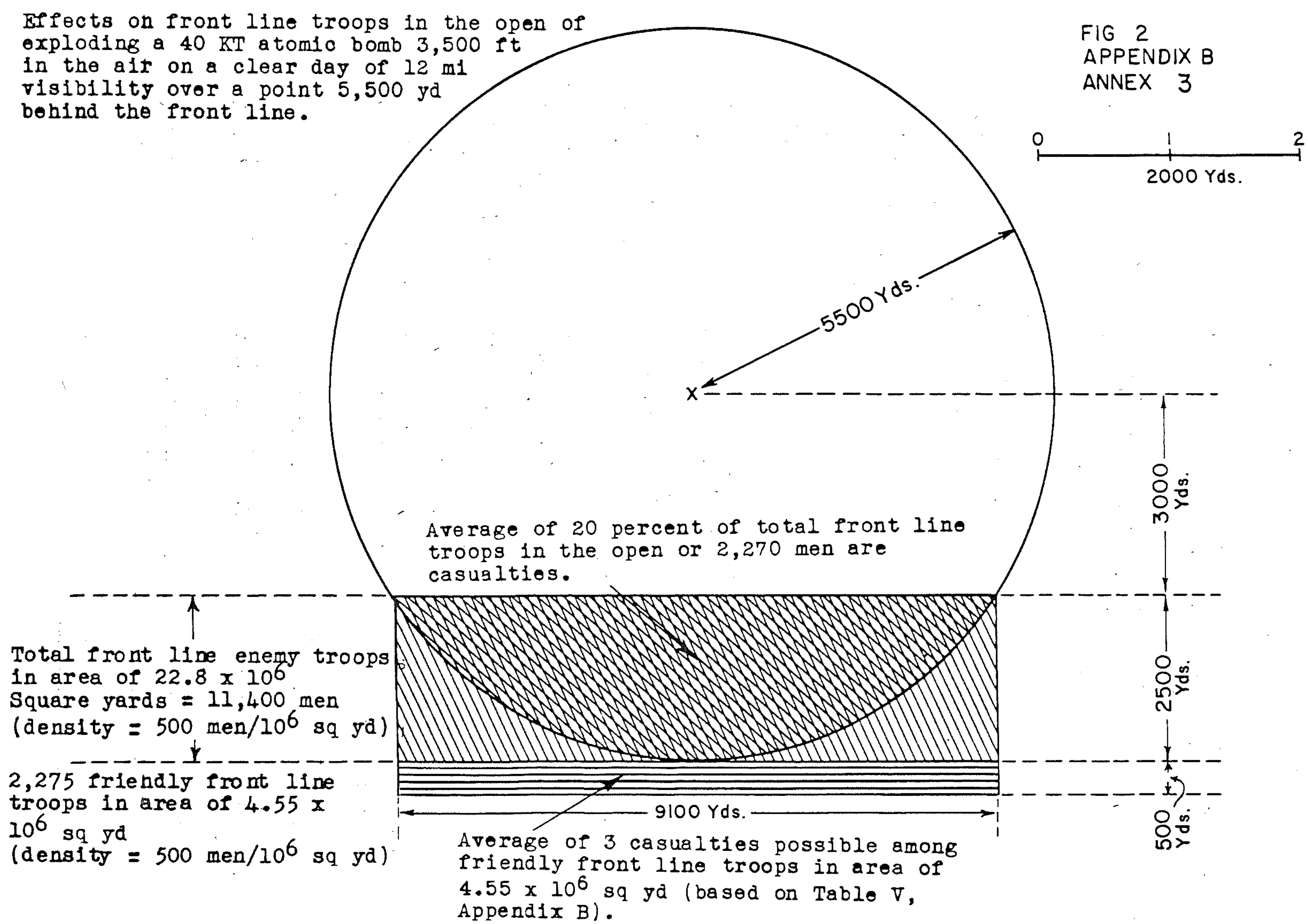
10. It consequently becomes necessary to consider exploding the weapon closer to the front line in order to obtain substantial effects against enemy front-line forces, in the defense of a perimeter line which has been set as the Pusan Inner-Defense Line. Such an action cannot be made during the time of an enemy attack since close contact cannot usually be avoided at such a time. The use of the weapon closer to the front line must therefore be made against line forces which are temporarily static, thus creating a "planned target." It is with this assumption that the following analyses are made, of the effectiveness of atomic weapons against enemy front-line forces.

First Situation;- Second Variation:

Aiming Point 5,500 Yards from Friendly Troop Line (Men in Open)

11. a. In Figure 2 is shown an evaluation of the results of exploding a 40-KT atomic weapon at a height of 3,500 feet on a clear day with visibility of 12 miles, over a point 5,500 yards from the enemy front-line forces, which is also the safe distance from ground zero for friendly troops in the open.

FIG 2
APPENDIX B
ANNEX 3



o. The only troops out of a total of 11,400 men, in the front-line area 9,100 yards long by 2,500 yards deep (22.8×10^6 square yards) affected by one air burst, will be about 7,940 men, based on the same conditions of density and deployment as described in paragraph 6.

12. One air burst under the conditions here described will produce about 2,270 casualties or about 20 percent of the total of 11,400 men in the front-line area. That is, one air burst at 5,500 yards from friendly troops is capable of inflicting moderate damage to enemy front-line forces deployed as described.

13. Also shown in Figure 2 is a front-line area 9,100 yards long by 500 yards wide (or 4.55×10^6 square yards) containing about 2,275 friendly troops, assumed to be in the open in the same density as the enemy front-line troops, and without a "no-man's-land" separation from the enemy. From Table V, Appendix B, it is found that for an aiming point 5,500 yards from forward elements and 6,000 yards from the rear elements of the UN troop line, only three casualties, or about 0.13 percent, may be expected among the friendly troops in this area from the use of one air burst in the manner described.

14. This situation is fairly good for use of an atomic weapon but still inadequate as an aid to perimeter defense, since reinforcement to cover a 20-percent enemy loss may be speedy and effective, and the unhurt 80 percent may be sufficient to continue the attack and breach the defense perimeter. Furthermore, an unduly large number of air bursts would be required, in ever decreasing efficiency as the tactics and training of the enemy improves, to accomplish the mission of a withdrawal or a holding of the perimeter. A still closer aiming point is obviously needed.

15. It is to be noted that so far the assumption has been made that all men are in the open. If many are in foxholes or under adequate cover, the aiming-point distances from the troop line so far considered will result in few or no casualties. Furthermore, the probable existence of a "no-man's-land" separation of, say, 500 yards between the friendly and enemy front-line forces will, in the situation here described, preclude casualties among the friendly troops.

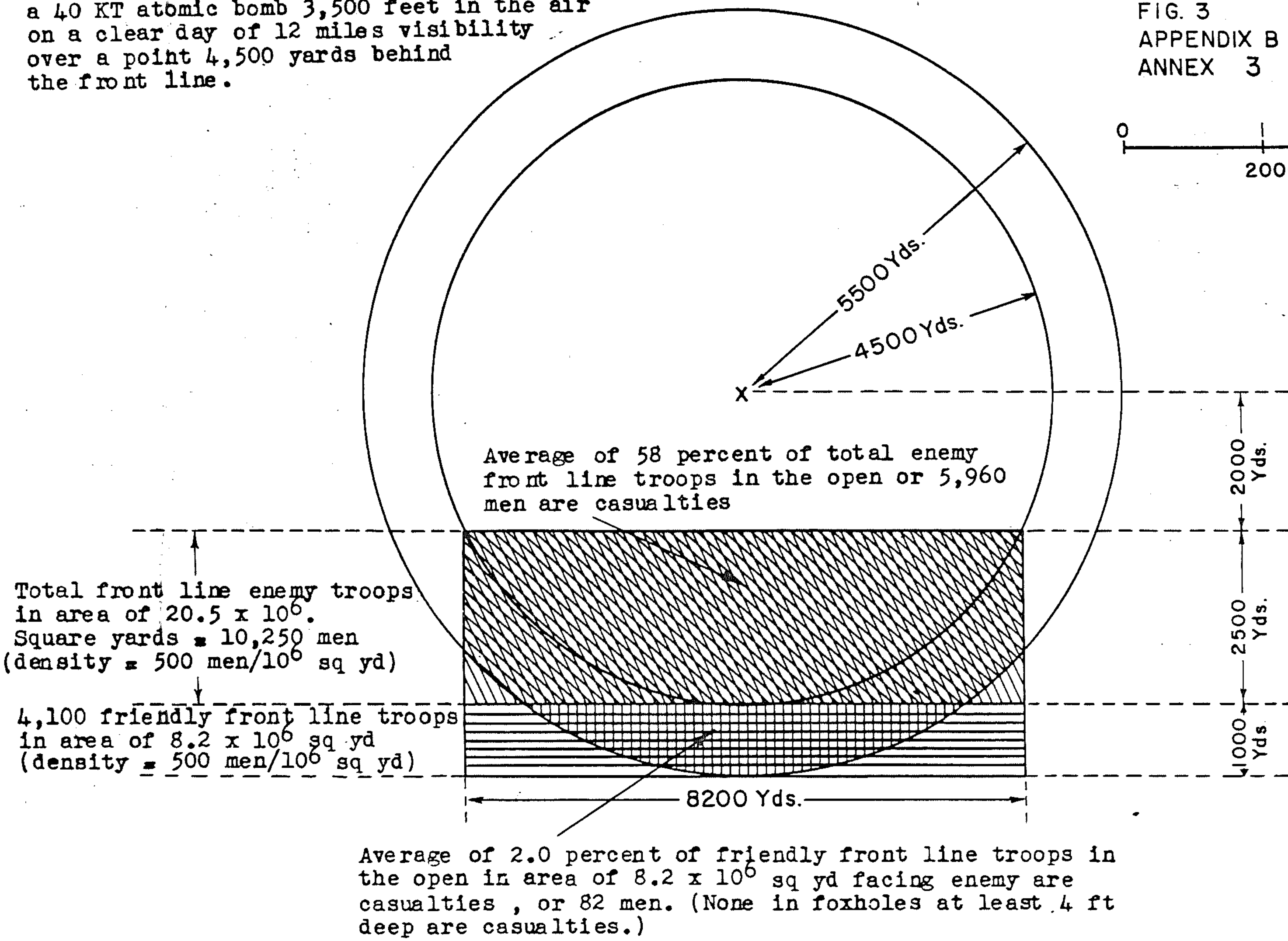
First Situation;- Third Variation:

Aiming Point 4,500 Yards from Friendly Troop Line (Men in Open)

16. Figure 3 shows the results of exploding the atomic

Effects of front line troops in the open of exploding a 40 KT atomic bomb 3,500 feet in the air on a clear day of 12 miles visibility over a point 4,500 yards behind the front line.

FIG. 3
APPENDIX B
ANNEX 3



weapon over a point 4,500 yards behind the front line. The men are still in the open and the deployment and density remain the same as before. Of the total of 10,250 enemy troops in the front line region of interest 8,200 yards long and 2,500 yards deep (or 20.5 x 10^6 square yards) about 5,960 men or 58 percent will be casualties. This represents severe damage to the enemy front-line forces and indicates an excellent yield from the use of one atomic weapon. Also, out of about 4,100 friendly troops, in an area 8,200 yards long and 1,000 yards deep (or 8.2 x 10^6 square yards) about 2.0 percent or 82 men may be expected to be casualties, using data from Table V of Appendix B and averaging over the whole strip.

17. Comparison of the numbers of casualties among enemy and friendly forces in the three variations of the situation so far discussed reveals, as shown in Table I following, a relative exchange ratio for the third variation over the second of about 46 to 1, obtained from the ratio

$$\frac{5960 - 2270}{82 - 3} = 47$$

In other words, reducing the distance of the aiming point from the troop line by 1,000 yards, from 5,500 to 4,500 yards, produced 3,690 more enemy casualties for 79 more friendly casualties, for an exchange ratio of 47.

TABLE I

CASUALTIES AMONG FRIENDLY AND ENEMY FRONT LINE TROOPS AS A FUNCTION OF THE DISTANCE FROM FRIENDLY TROOP LINE TO AIMING POINT

Distance From Aiming Point to Friendly Troop Line (yards)	Casualties				Relative Exchange Ratio
	Enemy		Friendly		
	Percent	Number	Percent	Number	
6,500	4.0	350	0	0	
5,500	20.0	2270	0.13	3	47
4,500	58.0	5960	2.0	82	

18. Table I indicates an excellent use of atomic weapons as an aid to perimeter defense. The severe damage inflicted on the enemy front-line forces is a strong deterrent against speedy or effective reinforcement or reorganization, and hence represents a high yield in tactical employment of a single atomic weapon. The relative number of casualties among the friendly troops is well within the expected daily

percentage of losses to enemy action,* although casualties may be considerably reduced or eliminated by the use of a "no-man's-land" separation between the forces, or by a policy of limited withdrawal of 500 to 1,000 yards, or by the use of adequate cover in the form of deep foxholes or terrain features.

19. a. On this basis, such use along the whole perimeter front would require, in supply, facilities for delivering simultaneously (within five minutes of each other, if necessary) a maximum of 12 atomic weapons to do severe damage to almost 60 percent of all the enemy forces facing the UN forces on the perimeter line.

b. This level of destruction might, if accomplished twice with a total available supply of 25 atomic weapons of the type considered in this discussion, provide adequate time intervals to permit the disengagement or evacuation of the UN forces from the perimeter holdings. That is, two atomic weapons for each of the 12 enemy divisions attacking the UN line would appear adequate for perimeter defense during withdrawal. Continued defense of this line, however, would require consideration of the length of time desired for holding the line, the availability of more atomic weapons than indicated here, the gradual reduction of the efficiency of the weapons with repeated use and the development of tactics and training to counteract or avoid the effects of atomic weapons. In such circumstances, the number of weapons required for prolonged defense might approach five per enemy division committed against UN lines.

Second Situation;- First Variation:

50 Percent of Enemy Front Line Troops in Foxholes; Aiming Point 4,500 Yards Behind Enemy Front Line; 500 Yards "No-Man's-Land" Separating Forces.

20. In this situation it is desired to evaluate the effects on enemy and friendly front-line forces when the former are half in the open, half in foxholes, while the friendly troops are all in foxholes or adequate cover and may have warning of the planned use of atomic weapons. It is assumed that a "no-man's-land" separation distance of 500 yards exists between the forces, and that both the enemy and friendly forces are concentrated in the same density. The height of the burst is taken as 3,000-3,500 feet.

* FM-101-10, pp 20-21 gives expected short-period battle losses in zone defense of 3.2 percent on the first day and 1.6 percent on succeeding days.

21. Troops in foxholes are safe beyond a distance of about 3,500 yards and it becomes obvious from Figure 4 of this Annex and Table IV of Appendix B that no casualties should be suffered by friendly troops. However, the enemy front-line forces in the area of interest, which is 10,200 yards long by 2,500 yards deep (25.5×10^6 square yards) total 12,750 men, of which number about 32 percent or 4,080 men, in the 50-50 foxhole-open situation become casualties. Obviously, adequate cover and a separation between forces are required for the protection of friendly forces from friendly atomic weapons.

Second Situation;- Second Variation:

50 Percent of Enemy Front-Line Troops in Foxholes; All Friendly Troops in Foxholes; Aiming Point 3,500 Yards Behind Enemy Front Line; 500 Yards "No-Man's-Land" Separation of Forces

22. a. Figure 5 shows the results of bringing the aiming point 1,000 yards closer to the front line, keeping all other conditions the same. Of a total of 13,500 enemy troops in the area of interest, 10,800 yards long and 2,500 yards deep, or 27×10^6 square yards, about 59 percent or 7,960 men will become casualties.

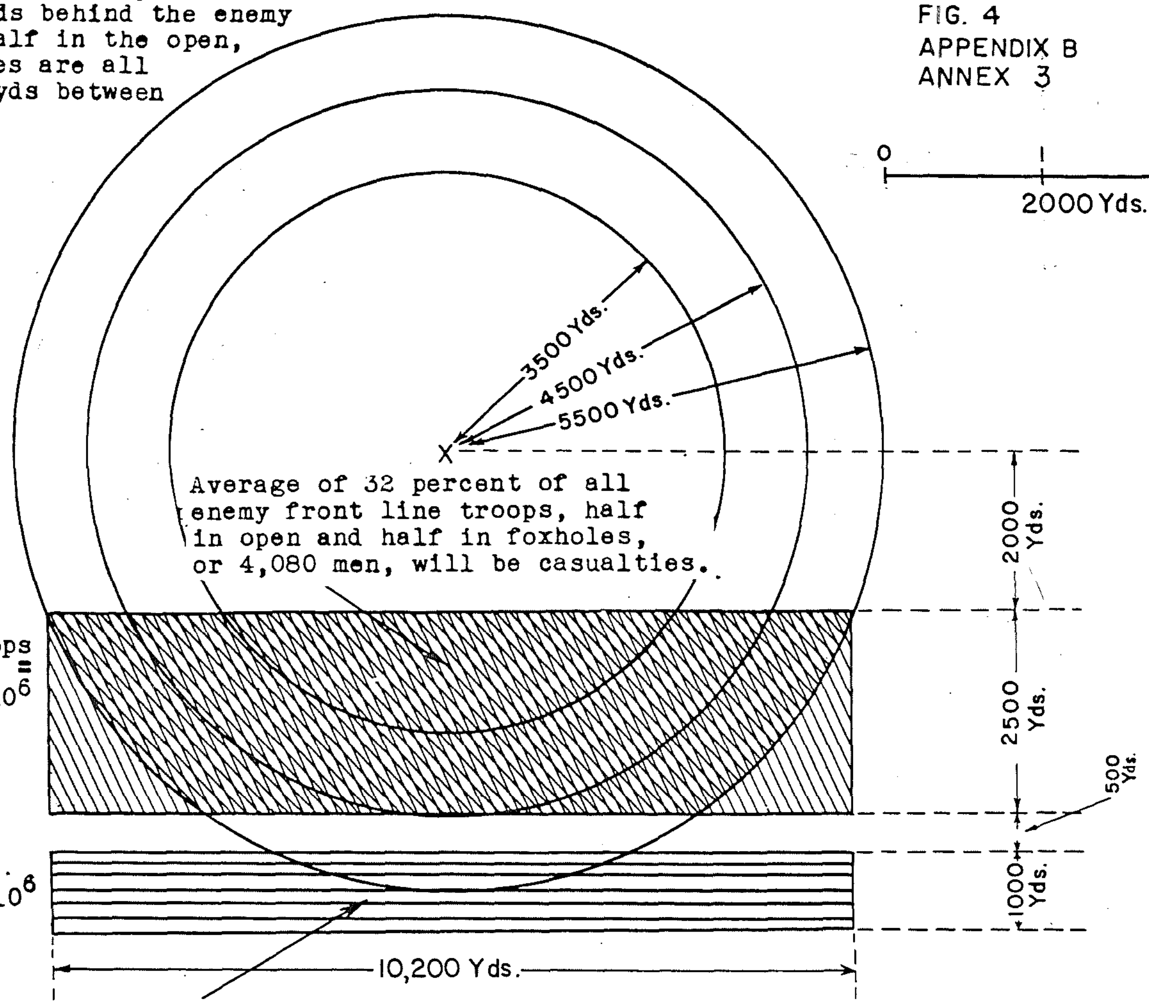
b. On the other hand, reducing the aiming point distance from the front line by 1,000 yards, will cause less than one friendly casualty if friendly troops are forewarned and are uniformly dispersed in deep foxholes in a belt 1500 yards deep and 4,000 to 5,500 yards from the aiming point (see Table IV, Appendix B). However, let it be more realistically assumed that roughly five percent of the friendly troops expose themselves in the open (Class A vulnerability). From Table V, Appendix B, there then will be about 15 friendly casualties among about 8,100 men in an area 10,800 yards long by 1,500 yards deep (or 16.2×10^6 square yards) if the aiming point is 3,500 yards behind enemy front lines, and two friendly casualties if the aiming point is 4,500 yards behind the enemy front line.

23. Comparison of the numbers of casualties among enemy and friendly forces in the above two situations, where large numbers of troops are in foxholes which are deep and offer very good cover against injury from atomic-weapon effects, are shown in Table II.

24. The figures of Table II reveal a relative exchange ratio for the second variation of the situation over the first variation of nearly 300 to 1, obtained from the ratio

Effects on front line troops of exploding a 40 KT atomic bomb 3,500 feet in the air on a clear day of 12 miles visibility over a point 4,500 yds behind the enemy front line. Enemy forces are half in the open, half in foxholes; friendly forces are all in foxholes; separation of 500 yds between the forces.

FIG. 4
APPENDIX B
ANNEX 3



Average of 32 percent of all enemy front line troops, half in open and half in foxholes, or 4,080 men, will be casualties.

Total enemy front line troops in area of 25.5×10^6 sq yd = 12,750 (density = 500 men/10^6 sq yd)

Total friendly front line troops in area of 10.2×10^6 sq yds = 5,100 (density = 500 men/10^6 sq yd)

No friendly troops in foxholes will be casualties.

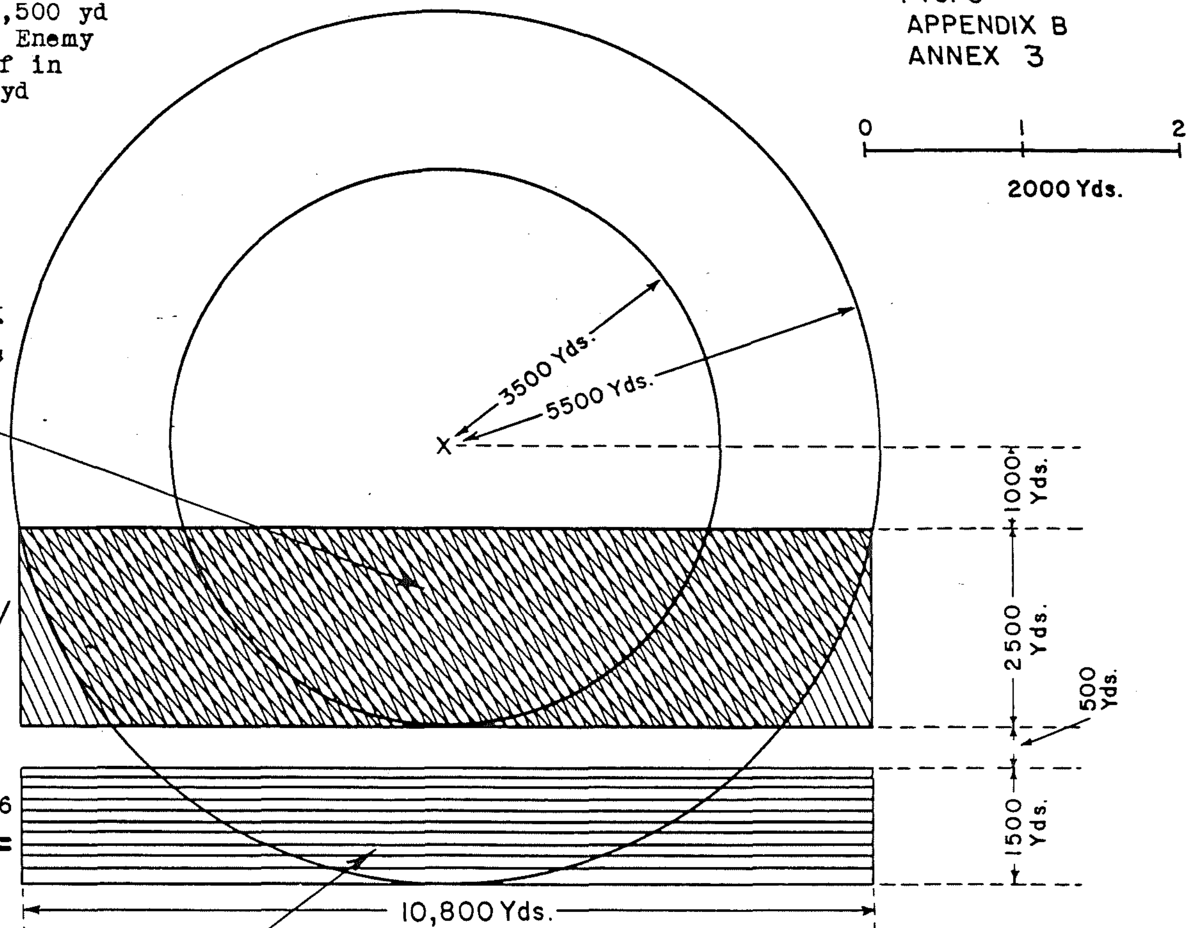
Effects on front line troops of exploding a 40 KT atomic bomb 3,500 ft in the air on a clear day of 12 mi visibility over a point 3,500 yd behind the enemy front line. Enemy forces are half in open, half in foxholes; separation of 500 yd between the forces.

FIG. 5
APPENDIX B
ANNEX 3

Average of 59 percent of all enemy front line troops half in open and half in foxholes or 7,960 men will be casualties.

Total enemy front line troops in area of 27 x 10^6 sq yd = 13,500 men (density = 500 men/10^6 sq yd)

Total friendly front line troops in area of 16.2 x 10^6 sq yd = 8,100 men (density = 500 men/10^6 sq yd)



Not more than 1 casualty among friendly troops in deep foxholes, however, an average of 4 percent of any friendly troops exposed in open would be casualties.

$$\frac{7960 - 4080}{15 - 2} = 300$$

In other words, reducing the distance of the aiming point from the friendly troop line by 1,000 yards, 4,500 to 3,500 yards, produced 3880 more casualties among enemy troops for only 13 more friendly casualties, for an exchange ratio of 300. This indicates an excellent use of the atomic bomb as an aid to perimeter defense.

TABLE II

CASUALTIES AMONG ENEMY TROOPS HALF IN FOXHOLES AND FRIENDLY TROOPS ALL IN FOXHOLES, SEPARATED BY A DISTANCE OF 500 YARDS, AS A FUNCTION OF THE DISTANCE FROM FRIENDLY TROOP LINE TO THE AIMING POINT

Distance From Aiming Point to Friendly Troop Line (yards)	Casualties				Relative Exchange Ratio
	Enemy		Friendly		
	Percent	Number	Percent	Number	
(4,500 + 500)	32	4080	0.025	2	300
(3,500 + 500)	59	7960	0.2	15	

25. The discussion regarding the number of bombs required in supply for simultaneous use against the enemy front-line forces with troops in the open also holds for enemy troops half in the open, half in foxholes. The required changes in practice involve adjustments in distance of aiming point from front line and the use of a "no-man's-land" separation distance between the forces. Hence about 12 bombs will give 60 percent enemy casualties to all front-line forces in a simultaneous drop, and force reinforcement and reorganization and perhaps withdrawal. Use of this tactic at least twice may aid materially in permitting the withdrawal of friendly forces from the perimeter holdings. However, a great many more bombs would be required for continued defense of the perimeter holdings.

APPENDIX B, ANNEX 4

COORDINATION AND TIMING IN ATOMIC ATTACKS INVOLVING MULTIPLE AIMING POINTS

Introduction

1. Appendix F discusses the steps necessary in planning and executing tactical atomic attacks by medium bombers. Annex 2 of that Appendix presents a check list of the various elements which must be considered in preparing and delivering an atomic attack by aircraft.

2. The purpose of the present Annex is to discuss atomic attacks by aircraft involving several aiming points* within a large area from the viewpoints of:

a. Safety of friendly troops.

b. Necessary ground control and guide-in systems.

c. Spacing between aiming points to be simultaneously attacked by one serial of a multi-plane attack.

d. Time and space intervals between successive serials of the coordinated attack.

e. Factors pertinent to the choice of Initial Points and axes of attack.

3. Three examples of hypothetical atomic attacks against actual enemy troop concentrations in the Korean Campaign will be discussed to illustrate planning procedures to meet the above requirements:

a. Six-bomb attack on an E-W line north of Imjin River (CCF concentration against Line Baker on 31 December 1950.)

b. Six-bomb attack on CCF troop assemblies in

*See Appendix B, paragraphs 46-52 .

the Pyonggang-Chorwon-Kumhwa triangle about 28 December 1950.

c. Two-bomb attack on CCF and NKA concentrations in the Wonju area about 8 January 1951.

CCF CONCENTRATION AGAINST LINE BAKER, 31 DECEMBER 1950.

4. Ground Situation. The ground situation along the Imjin River on 31 December 1950 is given in detail for CCF in Annex 1 of Appendix C and for friendly forces in Annex 1 of Appendix G. In brief, approximately 120,000 CCF and NKA troops were deployed against the I and IX Corps fronts in the region north of the Imjin. The Imjin River was the bomb line for conventional weapons. For atomic weapons, of course, a safety distance of approximately five kilometers would need to be added for a 40-kiloton weapon because of its greater range of effectiveness.

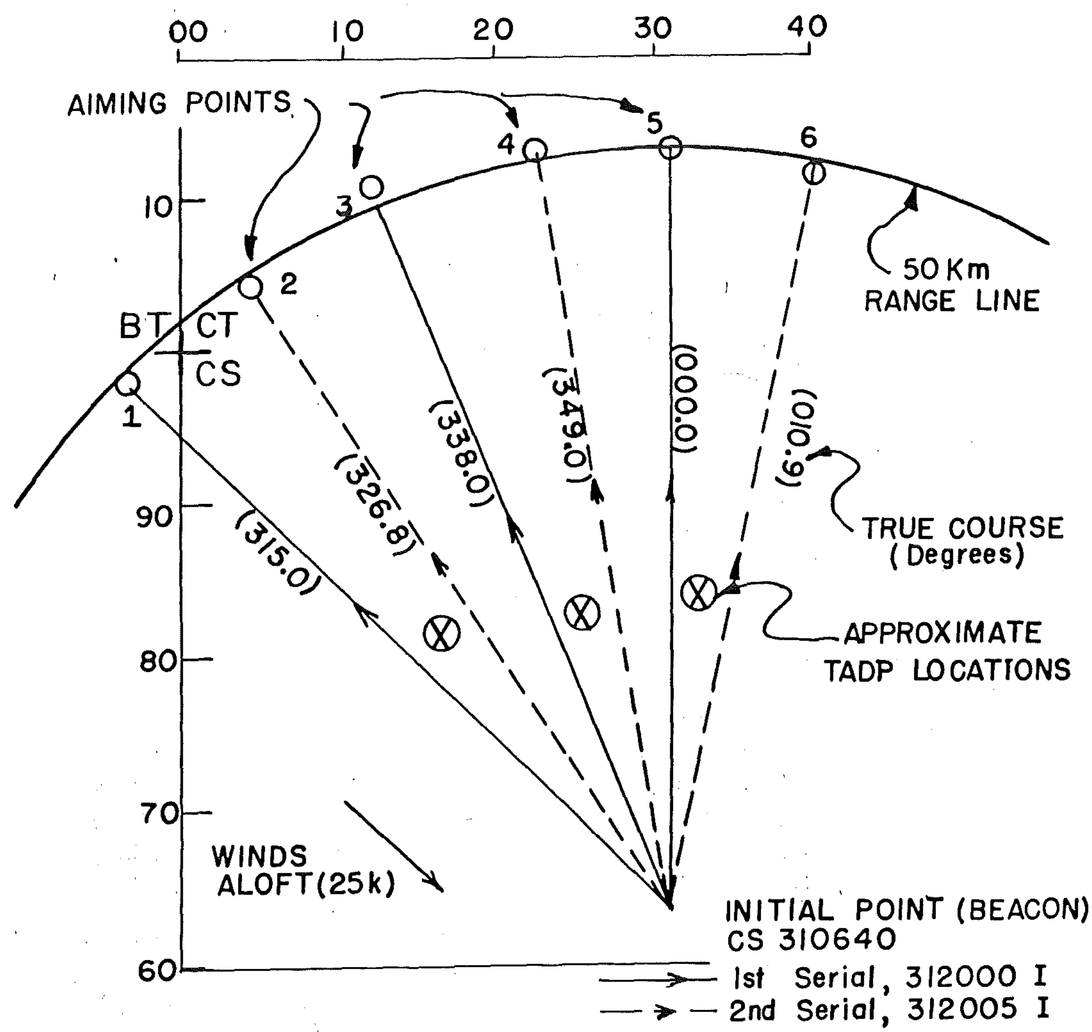
5. Aiming Points. A detailed study of enemy troop deployment, shown in Figure 1 of Annex 1, Appendix C, resulted in the selection of six aiming points as follows:

(1) BS 964983	(4) CT 214132
(2) CT 045045	(5) CT 310140
(3) CT 120110	(6) CT 403125

6. The Imjin River and adjacent flat land formed a sort of automatic no-man's-land between friendly and enemy forces. Consequently, the selected aiming points all were at least 6,500 yards from friendly MLR. That is, the added safety distances suggested in Appendix B for a bomb delivery error of CPE 500 yards were exceeded by about 500 yards.

7. Attack Plan. The six aiming points listed above lie in a shallow arc extending roughly in an E-W direction with its convex side toward the enemy--Figure 1. Consequently, the axis of attack would best be planned for bombing runs from S to N. Because of the arc-like nature of the line of aiming points, a single beacon located approximately 50 kilometers S of aiming point No. 5 could be used as the Initial Point. In the flight schematic shown in Figure 1, aiming points numbered 1, 3 and 5 would be attacked by the lead serial of three B-29 medium bombers, and aiming points numbered 2, 4 and 6 would be struck by a second serial of three B-29's following the first serial by about five minutes. This would allow sufficient time for the atomic clouds to rise and gamma-ray ionization clutter to clear from the areas bombed by the first serial.

8. Attacks would be delivered by high altitude, level



RANGE AND COURSE SCHEMATIC, A-WEAPON DELIVERY ON CCF CONCENTRATIONS NORTH OF IMJIN-GANG, 312000 I (DEC 1950)

FIG I APPENDIX B, ANNEX 4

bombing runs at approximately 20,000 feet. Each plane would be directed from Initial Point to bomb release line by a Tactical Air Direction Post (TADP) located between the Initial Point and friendly MLR.

9. TADP Requirements. Three TADP would be required for the target-marking and local ground control system*; i.e., one TADP for each B-29 in an attack serial. Each TADP would operate two separate ground stations: one would be a guide-in station to direct a bomber to the bomb release point; the other would be a track-in station for the sole purpose of approving bomb release (or aborting the sortie) as an additional assurance of friendly troop safety. The guide-in station might be either a radar or a Shoran type. The track-in station, of course, would have to be a narrow-beam radar type capable of tracking the individual bomber at all times during its bombing run from the Initial Point to the atomic bomb safety line.

10. Execution of Attack. The attack plan outlined above would be executed as follows: Each B-29 crew would be prebriefed on bombing altitude, Initial Point, and approximate course and distance from Initial Point to Aiming Point. However, each bomber, upon passing the Initial Point, would go under control of a TADP guide-in station which would give the range and course to the bomb release point. At the same time, a separate track-in station would independently pick up the bomber and follow it to the atomic bomb safety line. Track-in station would approve release of the bomb. The bomb then would be released upon receipt of a simultaneous or later command from the guide-in station. In the particular case under discussion, approval by track-in station would occur approximately three seconds (500 yards) prior to the bomb-release signal from the guide-in station.

this must have been the set up for Hudson Harbor work further?

11. The second serial of bombers would deliver attacks in exactly the same manner, except that they would arrive over the Initial Point five minutes after the first serial had passed. Since the time of fall for atomic bombs from a 20,000-foot altitude would be less than 30 seconds, the required safety-time interval of at least three minutes between explosions in adjacent target circles** would be met.

12. In summary, the above atomic attack plan would have the following features***;

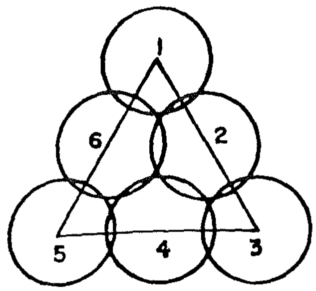
a. A minimum spacing, between bombs delivered in

* Appendix B, paragraphs 36-44.
** Appendix B, paragraph 52.
***Probable CCF casualties resulting from the attack are assessed in Annex 1, Appendix C.

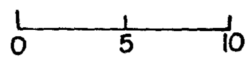
FIG. 2

(ANNEX 4, APPENDIX B)

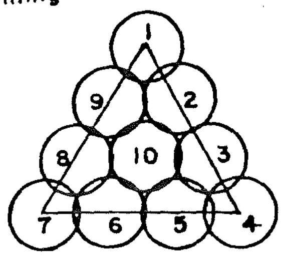
Neutralization of PYONGGANG - CHORWON - KUMHWA triangle by Six and Ten 40-KT Atomic airbursts at heights of 3,000 - 3,500 feet.



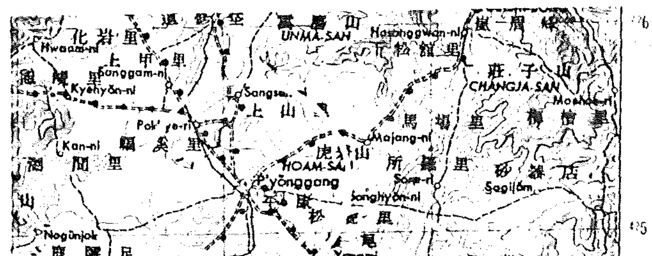
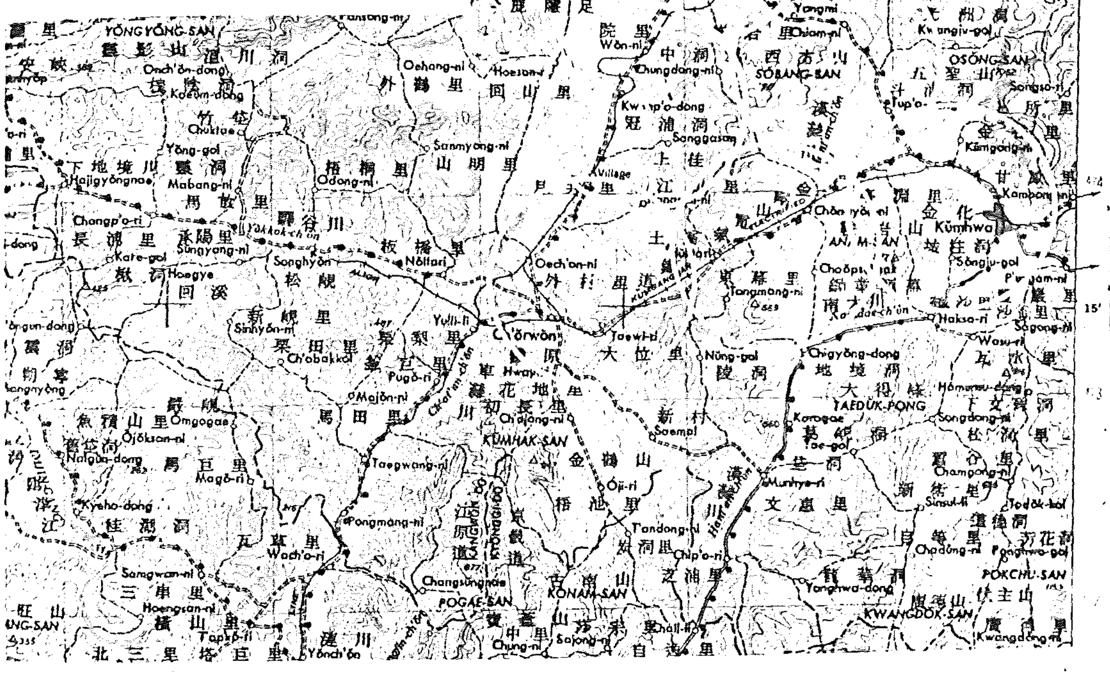
Aiming Point Scheme No. I.



Kilometers



Aiming Point Scheme No. 2.

the same serial, of approximately 17 kilometers, which is more than adequate for plane safety and for the prevention of atomic fizzles.

b. An elapsed time of about five minutes between atomic explosions in adjacent target circles, which would allow time for atomic clouds to rise, ionization clutter to clear, and excess neutrons to be absorbed.

c. A distance of about 50,000 yards between the first and second flight serials, which would be more than ample for protection of planes from blast interference and crews from flash blinding.

d. Positive ground control, both by guide-in and by track-in to assure the safety of friendly troops.

e. Bomb drops perpendicular to and away from friendly lines so that any delay in approval by the track-in station would increase rather than decrease friendly troop safety.

f. Maximum surprise by three nearly simultaneous explosions in each serial.

g. Delivery of a saturation attack on an enemy line roughly 50 kilometers long in a maximum time not exceeding approximately five minutes.

NEUTRALIZATION OF THE
PYONGGANG-CHORWON-KUMHWA TRIANGLE

13. Importance of the Area to the Enemy. Pyonggang, Kumhwa, and Chorwon, Figure 2, form an equilateral triangle with sides of 20 kilometers. The base of the triangle is about 20 miles from the 38th parallel. This triangular area has had special tactical and strategic significance in the Korean Campaign. Its importance is obvious from terrain and transportation route maps of Korea. Railroad and roads into the area from the north and west are protected by hills and ridges. Routes out of the triangle lead toward the south, southwest, and southeast.

14. The triangle has been used extensively by both CCF and NKA as a troop-assembly and supply area for mounting attacks into South Korea through the western and central sectors. In this Annex, the triangle will be used to illustrate the neutralization of a large area by multiple atomic air bursts.

15. New Intelligence Requirements. Intelligence* has indicated that two CCF Armies (corps), totaling 58,000, and one NKA division, strength 9,000, were in this triangle between 27 and 29 December 1950, prior to moving south and southeast to begin an attack on UN Line Baker along the 38th parallel on the night of 31 December - 1 January. Other sources** also indicate that elements of a third CCF Army in division to corps strength entered the triangle during the night of 26-27 December. That is, the total troop strength in this area on 28 December was probably 65,000 to 95,000.

16. Such a large troop concentration would have been a lucrative target for atomic attack. However, information on this concentration was not developed until after most or all of these troops had moved out of the area. Consequently, the following analysis is largely hypothetical. However, it will serve as an illustration of three facts: (1) that there are areas in which large troop concentrations may be anticipated; (2) that there is an urgent need for intelligence methods to obtain, transmit, and evaluate information on enemy concentrations behind the line of contact during the time that such concentrations exist; (3) that atomic weapons offer a means for neutralizing or destroying enemy ground forces prior to firm battle contact.

17. Methods of Attack. A multiple-weapon attack on the Pyonggang-Chorwon-Kumhwa triangle would differ from the preceding illustration of atomic defense of Line Baker in three respects: first, the aiming point pattern would be of an area rather than of a line type; second, the safety of friendly troops would not be a factor; third, consideration would have to be given to both civilian and enemy troop casualties.

18. All parts of the triangle were within 20 to 30 miles of UN lines on 28 December, so three different types of atomic bomb attack might have been used: (1) TADP designation of bomb-release points by electronic means; (2) visual bombing; (3) radar bombing.

19. TADP designation of bomb-release points probably would have been the more effective for three reasons: (1) CCF habits cause them to be more likely to be exposed or moving in the open at night; (2) TADP electronic target designation is capable of a smaller CPE than night bombing by radar; (3) timing between attack serials would be more closely controlled by TADP so as to maximize the element of surprise.

*OB and Analysis Branches, G-2, EUSAK.
**See Appendix C, Annex 4, paragraph 6a.

20. The peculiar geometrical shape of the Pyonggang-Chorwon-Kumhwa triangle immediately suggests coverage by the close-packed target circle patterns shown in Figure 2. Area coverage with little or no overlapping of damage circles would be obtained from 40-KT bombs spaced according to Aiming Point Scheme No. 1, in which the aiming points are 10,000 yards apart.

21. A more thorough area coverage, with overlap in the regions of partial damage, would be obtained from ten 40-KT bombs spaced about 7,000 yards apart in accordance with Aiming Point Scheme No. 2 of Figure 2.

22. Expected Damage. On the average, an area-coverage pattern like Aiming Point Scheme No. 1 might be termed an area neutralization pattern and Scheme No. 2 might be called an area destruction pattern. However, detailed examination of terrain and intelligence maps, or even a cursory look at the smaller-scale map of Figure 2, shows that Scheme No. 1 places most of the more likely centers of troop concentration fairly close to aiming points because of terrain features, access to roads and trails, and availability of existing shelter.* On this basis, the damage prediction criteria of Appendices A and B can be raised somewhat to give an estimated average area casualty percentage of 40 to 50 for Scheme No. 1. Scheme No. 2 would not fortuitously include any additional likely centers of concentration, so the average area casualty percentage would probably lie between 60 and 70 percent. Despite the lesser return per bomb, however, Scheme No. 2 would be the more attractive**, provided atomic weapons for tactical use were stockpiled in adequate numbers, since it would produce a greater number of enemy casualties.

23. Weapon Delivery Sequence. The atomic weapon delivery restrictions discussed in the preceding example (Line Baker) would also apply to the present case. That is, the time interval between flight serials would be five (plus or minus one) minutes, and no aircraft in the same serial would make atomic-bomb drops into adjacent damage circles. The flight plans for the present example can be laid out readily from these rules.

24. Suppose that the axis of attack is from S to N. Inspection of Figure 2 then indicates that three serials

* These factors tend to control troop deployment in nearly all cases. See Appendix A, paragraph 61 and Appendix B, paragraphs 73-74.

**See Appendix I for relative dollar costs of producing casualties with various weapons.

would be required for either the six- or the ten-bomb pattern. Since Pyonggang is probably the most important target, with Chorwon a close second, the sequence of serials should be planned to strike the corresponding aiming points in the same order in time. By inspection of Figure 2, it now is evident that for an axis of attack from S to N, the preferred sequence of delivery on each aiming point would be as follows:

Scheme No. 1

Serial 1: Aiming point 4 followed by 1, with an elapsed flight time of about 100 seconds for a B-29 medium bomber between the base and the apex of the triangle*.

Serial 2: Aiming point 5, followed by 2.

Serial 3: Aiming point 3, followed by 6.

Scheme No. 2

Serial 1: Aiming points 7, 4, 10 and 1 in that order, again with an elapsed flight time of about 100 seconds between drop 7 and drop 1.

Serial 2: Drops on aiming points 6, 3 and 9 in that order.

Serial 3: Aiming points 5, 8 and 2.

25. The aiming point coordinates for Scheme No. 1 would be:

(1) CT 510521	(4) CT 541370
(2) CT 572460	(5) CT 452357
(3) CT 625388	(6) CT 479439

A similar set of aiming points for Scheme No. 2 readily could be determined.

26. Allowance for elapsed time from the base of the triangle to the last aiming point in the final serial of either Scheme No. 1 or Scheme No. 2 would be about one minute for 300-knot planes. Since the interval between serials is about five minutes, the three-serial attack would require

*Delivery times in the same serial could be made nearly simultaneous by a more complicated attack plan involving turn-away by rear planes to avoid air blast from bombs delivered by lead planes.

about 11 minutes from the initial to the final atomic explosion.

27. Serial and drop sequences for other axes of attack (including mixed axes) can be established by the same procedures as used above. The preferred axes of attack usually will be chosen from considerations of such factors as: suitable Initial Point(s); best approach routes; avoidance of enemy defenses; relative importance of targets within atomic weapon damage circles; probability of exploiting surprise; direction and speed of ground winds and winds aloft; safety of return routes; and acceptable turning and rendezvous points.

DECIMATION OF NKA FORCES IN THE WONJU AREA, 7-8 JANUARY 1951

28. Enemy Situation. EUSAK intelligence overlays for 7 and 8 January 1951 show a concentration of 18,000 NKA troops in the Wonju "bowl." These intelligence maps indicate enemy deployments in a roughly elliptical region of major axis 16,000 yards and minor axis 10,000 yards. The terminal points of the NKA positions on the major axis were in the vicinities of DS04 and DS13; i.e., the direction of the major axis was approximately NW-SE, with terminal points established by high terrain at both ends of the major axis. Wonju, a major town of the region, is situated near the SE focus on this axis.

29. Early January was the beginning of several weeks of strenuous enemy effort (NKA and CCF) to advance to the south and southwest by eliminating the Wonju salient, for the obvious purpose of occupying blocking positions astride friendly MSR. He was opposed and eventually defeated by X Corps.

30. Friendly Situation. On 7 and 8 January, enemy was in patrol contact with 2d US Division and 8th ROK Division a few miles SW and S of Wonju. He also was in firmer contact, in at least battalion strength, with 7th ROK Division E of Wonju.

31. Credibility of Friendly Intelligence. EUSAK intelligence overlays and GHQ Daily Intelligence Summaries for the Wonju area on 7-8 January are possibly contradictory. The former indicate average NKA troop concentrations of 450 men per square mile in a 40 square mile area, while the latter report that patrols of company strength or less were able to operate within Wonju and other points on the major axis of enemy concentrations. Subsequent developments have indicated that the EUSAK interpretation was conservative

but realistic so the EUSAK estimate will be used.

32. Atomic Attack Plan. Assuming EUSAK intelligence to have been realistic, the reported NKA troop concentration might have been attacked decisively with two atomic bombs: first, a 40-KT bomb centered on an aiming point near Wonju; second, an obvious aiming point near the other focus of the elliptical area. Friendly patrols would have had to be withdrawn into the hills south of Wonju prior to atomic attack.

33. Local Meteorology. The attack plan would have been complicated by local meteorological conditions. Low clouds, overcast, poor visibility, fog, and snow showers occurred during 7 January and most of 8 January. A period of clear weather and scattered clouds began at about 081800I and ended about 082100I. If this short period had been used for a two-bomb atomic attack (40-KT each), the estimated NKA casualties would have been about 9,000. If atomic attack had been made during the period of less favorable weather, estimated casualties would have been 6,000 of the 18,000 NKA troops reported to have been in the area.

34. Elapsed Time. The use of two adjacent damage circles would require an elapsed time of at least three minutes* between the first and second attack serials. However, the basic attack plan would require only two bombers. Consequently, it should not have been particularly difficult to make the second drop within three minutes of the first drop, instead of planning for the five-minute interval between flight serials used in the two preceding illustrations.

SUMMARY

35. Attack plans involving the delivery of several atomic weapons simultaneously or in sequence can be kept reasonably simple. The principal factors are:

(a) Selection of aiming point and delivery sequence patterns adapted to the geometrical form of the area to be attacked.

(b) Determination of suitable Initial Points;

(c) Controls to assure safety for friendly troops.

(d) Planning of time and space intervals between explosions consistent with the safety of delivery aircraft and the prevention of low-order atomic explosions.

*See Appendix B, paragraph 52.

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APPENDIX C

INTELLIGENCE PROBLEMS IN THE TACTICAL EMPLOYMENT OF ATOMIC WEAPONS

INTRODUCTION

1. The great destructive power of atomic weapons, both as antipersonnel and as antimateriel weapons, has already been discussed in Appendix A. It has been shown that in most cases it is possible to express the physical effects of an atomic weapon at particular positions in terms of its TNT equivalent and the distance of the point under consideration from ground zero. Most corrections imposed by meteorology and cover are made by dividing targets into three classes.

2. The dependence of the severity of the physical effects on distance from ground zero is at best an inverse square relationship and often approaches an inverse cube. Consequently, if a large fraction of the effectiveness of the weapon is not to be wasted, it is important that the aiming point be chosen with considerable care. The weapon is already subject to some loss in effectiveness as a result of statistical errors involved in delivery. This problem is discussed in Appendix B, paragraph 15. When we add to this the losses resulting from inaccuracies of intelligence (see Appendix B, Annex 1) the effectiveness of the weapon may be reduced to an uneconomical level and friendly troops may even be placed in peril (see Appendix B, paragraphs 16-30).

3. Sequentially, the tactical employment of atomic weapons involves the location and identification of enemy forces, the evaluation of the target, the preparation of an exploitation plan, and the delivery of atomic attack. Accurate and reliable intelligence is critical in the first two stages of this sequence. It is the purpose of this appendix to discuss the problems of intelligence, and to suggest methods for the improvement of intelligence analysis and consequent improvement in possible effectiveness of atomic weapons.

4. Throughout this discussion, it should be kept in

mind that atomic weapons will broaden the areas over which ground forces can be attacked effectively. The enemy's reserve and bivouac areas, his logistics and supporting services, and his communications and commands may be attacked with atomic weapons to a degree of decisiveness only faintly foreshadowed by tactical aircraft armed with conventional weapons. Consequently, intelligence and counterintelligence procedures and methods must be increasingly concerned with rear areas.

INTELLIGENCE DATA REQUIRED

5. The intelligence data required are those necessary to identify a suitable target in time to permit delivery of atomic attack. Suitability of a target must be defined in terms of numbers of enemy personnel and equipment, located by proximity to a point location, and by area distribution or dispersal. Equipment targets should be specified by types as well as by numbers. For some targets, such as enemy command posts and headquarters, numbers may be relatively less important. When numbers are not available, they may be represented by unit designations such as regiment or division. The short duration of tactical targets, and consequent urgency of the time requirement, make it important to attempt speed and precision in timing of intelligence information at all stages. In the tactical employment of atomic weapons, in addition to the accurate knowledge of terrain and weather required for all ground operations, intelligence may be required also concerning the geological substructures of certain regions.

PERTINENT GENERAL SOURCES AND PROCESSES

6. Intelligence sources will in general be of familiar character. They will presumably include:

a. Patrol reports.

b. Photo reconnaissance.

c. Artillery air and ground observation posts.

d. POW interrogations.

e. Air liaison planes under ground force control.

f. Air force observation.

g. Clandestine agents.

h. Friendly local sources.

i. Monitored communications.

j. Line crossers.

k. Escaped friendly prisoners.

l. Civilian refugees.

m. Organized guerrillas.

n. Underground civilian organizations.

7. The sources listed are not necessarily all-inclusive but they are adequate to illustrate several facts:

a. That some sources bear specifically on one type of possible atomic target but not on others.

b. That sources enter into intelligence organization and processing at different levels ranging from regimental S-2 to theater G-2.

c. That reliability of sources and credibility of information are independent and highly variable, so that each must be evaluated separately (see Annex 1, Table I, for evaluation scales).

d. That most information on possible area targets will be fragmentary and piecemeal, so that it certainly will require integration and also may require planned supplements before a target can be evaluated.

e. That the elapsed time between observation by the source and receipt of information at an intelligence center may range from a few seconds to weeks, so that additional reconnaissance may be required to confirm the targets continued existence or to spot its new location.

INITIATION OF TARGET IDENTIFICATION

8. The identification of a suitable target will presumably begin with the receipt of some information which serves as a "trigger," initiating evaluation or reconnaissance procedures which culminate in an intelligence judgment that a suitable target has in fact been identified. Given the nature of the sources and the varying levels at which they enter the intelligence mechanism, such a trigger may occur in any part of the intelligence system from any regimental S-2 to division, corps, army, or even theatre G-2. The important thing is that <u>after</u> the trigger occurs, and the hypothetical identification of a target begins to be

developed into the firm intelligence judgment that a target has been found, it will be necessary to develop, as quickly as possible, the required target data, fully evaluated in intelligence terms.

ACCURACY REQUIRED

9. The actual effects attained in the use of the weapon will not be the same as the effects estimated in advance. Two classes of errors will enter into this:

a. Errors in delivery by aircraft, guided missile, or heavy artillery: the CPE, or circular probable error. (See Appendix E, paragraphs 5, 10, and 14).

b. Errors in the intelligence identification and location of the target.

10. Errors in the identification and location of the target by intelligence may be of five kinds:

a. The error in estimating the point location of the target center; more precisely, the statistical sum of all the intelligence errors affecting the geographic location of the aiming point, referred to as σ_I in Appendix B, Annex 1.

b. The error in estimating the size of the target, in terms of numbers of men and equipment.

Relates to SOP.

c. The error in estimating the area over which the numbers are distributed in proximity to the target center.

d. Errors in estimating the distribution of target components within the target area.

e. Errors in distinguishing friend from foe.

11. A separate limit of acceptable accuracy can be specified only for the fifth of these intelligence errors; in general, the allowable error in distinguishing friendly from enemy targets must be zero because of the weapon's great destructive power. The first four intelligence errors, taken together, then, constitute the total allowable intelligence error. They cannot be considered separately 1/ in specifying limits of acceptable accuracy for target intelligence. However, their net effects in determining total casualties can be readily estimated by methods outlined in Appendix B, Annex 1.

1/ Paragraphs 13, 14, 15 on page 118 of ORO-T-1 (FEC), where separate accuracies are specified, should be disregarded.

12. Two fictitious situations are presented to demonstrate the use of the curves in Appendix B, Annex 1.

a. Troop concentration. Assume that intelligence places an estimated 5,000 to 12,000 troops in an assembly area of 12 to 30 million square yards (4,000 to 6,000 yards diameter), and that intelligence sources have been able to locate the center of concentration within an area of about a square mile (radius 1,000 yards). Entering Appendix B, Annex 1, Figure 1 Σ=1,000 yards) with 5,000 total troops and 6,000 yards target diameter gives a minimum of 3,500 casualties. Entering Figure 1 with 12,000 total troops and 4,000 yards target diameter gives a maximum of 9,500 casualties. The conditions of the problem therefore indicate that between 3,500 and 9,500 casualties will result from a 40 KT atomic airburst at a height of about 3,500 feet over the target center specified by intelligence.

Further, suppose that known enemy practice usually assembles a division, organizational strength 13,000, in an area of these dimensions, randomly distributed in concentrations that rarely exceed 300 to 400 troops per million square yards, but that enemy divisions are known to be understrength, averaging 10,000 troops. It now follows that the target is more probably a division (10,000 troops) in an area of about 6,000 yards diameter. Figure 1, Appendix B, Annex 1, when entered with these numbers yields an estimated 6,000 casualties.

b. Bivouac area. Now consider the case of a bivouac area for which intelligence is not so reliable as in paragraph 12 (a) and consequently Σ is chosen as 2,000 yards. (This places the probable center of the target within an area of four square miles in contrast with one square mile for Σ = 1000 yards in the preceding example.) Some intelligence sources indicate that as much as a division may be bivouacked in the area which has a diameter of 6,000 to 8,000 yards. Other sources indicate that no more than a regiment of about 2,500 troops is occupying the area. Proceeding as in paragraph 12 (a), but now entering Appendix B, Annex 1, Figure 2 (Σ = 2,000 yards), an estimated 900 to 1,100 casualties may be expected within the regiment. If a division of 10,000 troops were in occupation, the estimate would be 3,500 to 4,500 casualties; i.e., four times the number estimated for a regiment in the same target area.

13. The two illustrations in the preceding paragraph indicate clearly that intelligence does not need to specify each of a number of variables with high precision. Rather, the limits of confidence, set by the interplay of all

intelligence factors, are the important objective. Thus, in the first example, it was indicated that a division would be knocked out of action because at the least, the total casualties would be 30 percent of total division strength, strongly concentrated in half of the division's elements, and more probably the casualties would be 60 percent, distributed over the entire division. The larger geometrical uncertainties in intelligence assumed in the second case still permitted a minimum of 35 percent casualties; the controlling intelligence error was instead the assumption that intelligence did not know whether a division or only a regiment would receive these casualties. (See paragraphs 49-54 following.)

14. The two preceding examples were "point" targets in the sense that only one 40 KT weapon was required to cover the target area. When larger areas and more than one aiming point are involved, similar analyses may be made from the curves for troop densities (men per million square yards) presented in Appendix B, Annex 1, and allowable limits of intelligence error can be established. As the size of the target area grows, the requirements for accuracy in locations diminish, but the requirements for accuracy in estimating troop numbers and/or densities do not. In fact, as discussed in paragraph 61 of Appendix A, topographical features of the target region tend to control the boundaries of target areas and the deployment of troops within these areas, but only alert intelligence can ever give clues as to whether any troops actually are present. For examples of larger area targets in Korea, refer to Annex 1, this Appendix, and to Annex 4, Appendix B.

15. Each of the several real situations drawn from the Korean campaign for studies presented in the various appendices and their annexes to this report may be scrutinized by the procedures of paragraphs 12, 13 and 14 preceding. In each of them, the limiting factors in intelligence, from the atomic weapon viewpoint can be identified.

TIMING REQUIREMENT

16. In Appendix F, Annex 1, the time required for the various operations which must occur after first target identification and before actual drop of an atomic bomb on a tactical target by medium bombers is estimated to be at least 12 hours. The development of new weapons and of new means of delivery (see Appendix E) could cut this time by perhaps one half. The rest of estimated time is allotted to intelligence and operational processes. These processes might be shortened somewhat by new procedures and

organizational changes discussed in Appendix D. Many important targets--for example, troops departing from an assembly area--may dissipate in two to four hours. Given the probable short duration of many tactical targets it is obvious that all intelligence processes which may be required before a firm intelligence judgment can be transmitted to command must be expedited to the utmost.

17. The time required for different intelligence processes may vary considerably. For example:

a. Air force observation may confirm the presence of thousands of troops in an area (see Appendix D, Annex 1, for an example in the Korean campaign) and establish and transmit by radio the target coordinates in a matter of minutes.

b. Photo intelligence may establish beyond doubt that a suitable target existed at a certain place when the photo was made, but return from sortie, development, printing, and photo interpretation will require at least one to two hours. (For a description of army photo reconnaissance and photo interpretation deficiencies in Korea, see paragraphs 43 and 44 following.)

c. A prisoner of war may assert that an enemy unit is at a certain location. His information will be hours to days old. Furthermore, POW interrogations are not credible until confirmed from other sources. Polygraph tests probably can be used to establish reliability ratings for POW sources, 2/ but even so, the POW may be misinformed, so confirmation by order of battle type information and by reconnaissance would be required before the existence of the target could be established.

18. It is apparent, then, that the time from receipt of trigger information to a firm judgment by responsible intelligence officers that a suitable atomic weapon target indeed exists may range from a few minutes to many hours. The time will depend in large measure on the amount of confirmation and supplement required to evaluate the target and upon the means available for obtaining additional intelligence. On occasion, an added handicap may be imposed by the desirability of keeping the target unaware that it is under surveillance.

19. Even when the trigger information is of high credibility, special arrangements will be required if the final intelligence judgment is to be reached as quickly as possible. This will require not only organization to bring all necessary intelligence competence to bear on the question in shortest time but also close liaison between

2/ ORO-T-5 (EUSAK) Military Applications of Polygraph Technique intelligence and operations. The joint G-2/G-3 problems raised by the propective tactical employment of atomic weapons are discussed in Appendix D.

20. Troops are usually more vulnerable to atomic attack when in the open or in movement, (see Appendix A, paragraph 84 for a discussion of classes of troop vulnerability). A part of the intelligence timing requirement then, is the desirability of predicting the time at which a given target can be attacked most effectively. For rear area targets, this may be accomplished by a study of enemy habits or by the rapid transmission of intelligence from sources having the target under surveillance. Near front lines, a multitude of sources can usually be exploited to arrive at a reliable prediction of the enemy's most probable course of action. Thus, in the CCF attack on Line Baker on 31 December 1950, the probable enemy jump-off time was predicted accurately by corps and army G-2 (see Annex 1 of this Appendix).

ANTICIPATED TARGETS

21. Anticipation of targets presents a different set of problems for intelligence from the ones relating to targets that occur fortuitously and at random. Thus far, the discussion has tacitly assumed the latter types of target; that is, targets of opportunity of which intelligence receives information with no foreknowledge of where and when and what they may be. It is true, however, that there will be many tactical atomic targets whose occurrence can be foreseen, in terms of probable time, place, and character. Intelligence scrutiny can be focused upon these places in advance, so that much of the required intelligence effort can anticipate trigger information.

22. Concentrations of troops and equipment, suitable for atomic attack, occur in the processes of military movements, of logistic support, and of ordinary housekeeping activities in any army. These concentrations occur near certain expected points: major installations of fixed equipment, freight handling and trans-shipment points, or route junctions and bottlenecks. The probability that suitable targets will occur, or persist, at such points is foreseeable. It generally will not be possible to predict the size, time, and duration of targets of this sort, but it will be perfectly possible to predict locations where they are likely to be found, and times when they are most likely to be present.

23. A further possible class of anticipated targets may be called induced targets. In the course of a battle

or a campaign, it is not unusual for one side to take actions which make reactions by the other side predictable. Thus, threat to an important point induces defensive concentration, or the presentation of an exposed flank invites attack. This is commonplace, but several observations may be made:

a. Our moves may make certain countermoves by the enemy quite probable, even though it may not be our intention to induce this counter.

b. We also may make moves for the primary purpose of inducing a countermove by the enemy.

c. His own moves in the recent past, together with his known tactical doctrines, may make certain of his moves in the future highly probable.

24. During the period covered by this report (November 1950-February 1951) all of the more lucrative of the enemy targets identified for hypothetical atomic attack, with the single exception of the CCF 66th Army at Taechon, were or might have been anticipated by intelligence by times ranging from several hours to several days. This would not necessarily be true of a different enemy. Despite the difficulties of our intelligence in spotting and following enemy movements, his moves usually have been ponderously slow, in character with his primitive logistics and transportation, so that his capabilities and probable course of action have often been evident to intelligence during build-up. In contrast, our own mechanized troop movements would have been more difficult for him to anticipate for atomic attack by appreciable periods despite our lack of concealment, while our large logistical installations and our airfields have been fixed and obvious points for atomic attack at all times (see Appendix G).

<u>CHANGE IN CHARACTER OF THE PROBLEM AFTER INITIAL USE</u>

25. The capability of the enemy to consider battle experience, and to make some degree of adaptation of his tactics and dispositions is a known fact. The extent and effectiveness of his adaptations is, of course, not knowable in advance. (See Appendix J for a lengthier discussion of some possible enemy reactions to the use of the atomic weapon).

26. It can be assumed that the use of atomic weapons will receive maximum intensity of attention by the enemy. Whatever degree of intelligent adaptation may be within his capability, he will make the utmost effort. His effort will presumably include:

(a) Changes in tactics and dispositions intended to reduce the frequency and value of targets presented.

(b) Changes in procedures meant to increase the difficulty for our intelligence in identifying such targets as are unavoidably offered by him in the course of his operations.

27. Such a reaction poses a special problem. If the occurrence of lucrative tactical targets will be more rare, and their identification more difficult, after the initial use of atomic weapons, then it will be important to judge carefully the occasion on which they may be employed with decisive effects in the first instance. This adds another factor to the intelligence requirement. Intelligence must locate, if possible, not single targets of limited value but many, or one or more exceptionally large targets. To accomplish this, intelligence must meet requirements in accuracy and speed in not one situation but in several situations simultaneously. It follows that the necessary intelligence personnel and equipment to accomplish these objectives must be organized and trained in advance of any possible need for them.*

THE REAR AREA PROBLEM

28. Present intelligence capabilities. In military experience all weapons are subject to substantial degradation factors. This means that actual weapon effectiveness is only a fraction, often a very small fraction, of expected or theoretical effectiveness. There are many factors contributing to degraded performance, but limited friendly intelligence probably is always one of them. As the destructive power of the weapon increases, the importance of intelligence as a limiting factor in weapon effectiveness continually increases also. In the case of atomic weapons employed tactically against ground force targets, friendly intelligence and enemy countermeasures may become the only two factors of major importance in finally determining weapon effectiveness.

29. Atomic weapons offer, in principle at least, the first available means of neutralizing large enemy-held areas rapidly, economically, and effectively. (See Appendix I, for an analysis of total costs and delivery capabilities for atomic weapons compared to other "area" weapons.) These areas include the reserves, logistics, tactical air forces, supporting services, communications, and command posts in

*See Appendix D, especially Paragraphs 10-14 & 19-24.

his rear, in addition to his front line arms.

30. In the Korean campaign, army intelligence of enemy rear areas has been of low efficiency. This is not necessarily either surprising or alarming, since ground force intelligence staffs scarcely can be expected either to neglect their real and immediate front line problems to pursue hypothetical problems involving future weapons, or to intrude in domains presently of primary air force cognizance. Nevertheless, this intelligence deficiency indicates that intelligence is probably the least prepared of any branch of the US army to cope with the problems of atomic warfare. Nor is rear area intelligence necessarily a hypothetical problem pending the initial use of atomic weapons. It seems clear, for example, that deficiencies in this area may have caused an underestimate of enemy capabilities in November 1950 and an overestimate a few weeks later.

31. Some of the machinery necessary to employ atomic weapons tactically already exists in army intelligence, and this machinery can be adapted quickly. This is primarily true, however, only of areas on or near the front in quasi-stabilized situations. For example, Annex 1 of this appendix presents a case of high intelligence efficiency in determining enemy build-up against Line Baker north of Seoul in the period 17-31 December 1950; Annex 2 is a case of considerably lower intelligence efficiency in determining probable enemy concentrations in the Taechon area in late November; Annex 3 illustrates a very low intelligence efficiency for determining the probable size and density of personnel targets from GHQ Daily Intelligence Summaries during November; Annex 1 of Appendix D shows a partial failure to anticipate and exploit a large troop target with conventional weapons; and Annex 4 of Appendix B gives two cases in which intelligence transmission was probably too slow to have permitted effective atomic attack on lucrative targets. It should be repeated, of course, that the efficiency ratings given above apply to the hypothetical use of atomic weapons, and therefore should not necessarily be construed to be critical of intelligence in its present missions.

32. Development of future procedures. There are a number of ways in which intelligence of enemy rear areas is obtained at present. There are not likely to be any radically new ones. This means that our only recourse is to develop more extensively those that we now have. These sources are familiar to every intelligence officer; the only reason for reiterating them is to examine the possibility of adapting them to atomic warfare. Rear area intelligence is so difficult that all sources will and must be exploited to the utmost, of course, so the discussion

following does not imply that any source should be neglected.

33. Ground sources. Line crossers and refugees are mostly friendly but their reliability is difficult to establish; they generally are untrained in military observation; their information is fragmentary and usually old; and credibility is hard to assess. Organized guerrillas are reasonably reliable, but contain criminals, adventurers, brigands, and possibly enemy agents in addition to patriots; they have some training in military observation and must necessarily be familiar with their locality; if equipped with radio or other communications, they can forward timely and valuable information. Much the same statements apply to underground organizations and to individual clandestine agents as apply to organized guerrillas. Unlike the guerrillas, they will control no territory, so their communications may be poor if they must be too careful to be timely or too clever to be understood unambiguously. Airborne intruder patrols, equipped with radio and dropped by parachute behind enemy lines, may be selected for their familiarity with local terrain, language and customs, and operate clandestinely. Or they may operate as military units, particularly if they are able to link up with or organize local guerrillas.

34. It may be concluded that all ground sources of intelligence for the tactical employment of atomic weapons against enemy rear areas will be effective principally to the extent that they can communicate credible information quickly. This nearly always will imply the clandestine use of radio and the concomitant avoidance of enemy interception or radio direction finding.

35. Aerial sources. The primary aerial sources of intelligence on enemy-held areas are visual observation and photo reconnaissance. Visual observation, particularly by bombers and fighters, has low credibility, but it can be of high value in triggering detailed reconnaissance, especially if results are communicated immediately by radio rather than held over for debriefing at completion of the mission. There are at least three reasons for lack of accuracy in aerial visual observation by pilots and crews: (a) many have no training in observing and interpreting ground force targets; (b) they often are not familiar with the neighborhood and even when they are, significant changes may escape notice by their visual memories; and (c) the inherent requirements for accurate visual observation are incompatible with the speeds and altitudes at which these planes fly, particularly over rough terrain.

36. Visual observations by T-6 (Mosquito) planes have

a higher credibility, but these observations also are best used as triggers (see paragraphs 21 and 22 of Annex 4 for experimental proof of limited efficiency in visually estimating troop targets from Mosquitos) for further reconnaissance. These slow, low-flying planes have been used extensively in Korea. Their usefulness is problematical under other conditions where enemy tactical aircraft or strong antiaircraft fire may be encountered.

37. Photo reconnaissance offers one of the most promising methods for obtaining accurate information on rear area ground force targets. The discussion and experimental trials with friendly and enemy troops reported in Annex 4 show that large-scale vertical aerial photos (1:2,000) will give the desired results. Extensive and random photography at this scale would involve a very large and possibly uneconomical effort, so detailed photo reconnaissance would need to be limited to profitable areas, and consequently, may require triggering by other sources of intelligence. Some of the applicable methods and procedures for planning and using large scale vertical photo reconnaissance also are discussed in Annex 4.

38. It may be concluded, then, that aerial photo reconnaissance offers a good chance for a simultaneous solution of three of the principal problems of rear area intelligence for tactical atomic warfare:

a. To deliver accurate information quickly.

b. To obtain detailed information covering extensive areas.

c. To escape interception and destruction by the enemy.

Further means for triggering photo reconnaissance should be studied and exploited by intelligence.

39. <u>Message interception and radio direction finding</u>. Message interception ranges all the way from theft or capture of enemy documents to the cryptographic decoding of enemy messages. When successful, it obviously offers one of the most accurate sources of information on enemy capabilities and courses of action, although caution to avoid "planted" false information is always necessary. Radio direction finding over land usually indicates only the approximate locations of enemy activities and command centers, since land masses refract radio waves and introduce bearing errors; furthermore, radio antennas may be located at a distance from a communications center.

40. Conclusion. A review of applicable intelligence sources indicates no new sources for obtaining information on which to plan tactical atomic attacks on enemy-held rear areas. It is seen, however, that existing means are capable of fuller exploitation, better integration, and improved methodology. One of the more promising methods for locating and evaluating atomic targets in the enemy's rear is large-scale vertical aerial photography.

LIMITATIONS AND DEFICIENCIES OF ARMY GROUND FORCE INTELLIGENCE, KOREAN CAMPAIGN.

41. The principal limitations and deficiencies of ground force intelligence in the Korean campaign, some of them self-imposed, will be discussed briefly. The point of view is primarily that of atomic warfare, but the discussion has bearing on warfare in general.

42. Patrols. Ground patrols usually are reliable and bring in credible information. The high intelligence efficiency on the Line Baker front was principally the result of patrol activities (see Annex 1). In common with observations by individuals, US army patrols have a tendency to overestimate the strength of opposing forces, particularly if the patrol receives fire or is in danger of being cut off. The cause may be lack of adequate training in the self-sufficiency of isolated units and in patrol functions. This may be reflected in the comparison of US army casualty rates (5.5 percent missing, and 3.8 percent killed, and 15.3 percent wounded) with those of the US Marines (0.7 percent missing, 6.2 percent killed, and 27.7 percent wounded.) 3/ That is, 1 out of every 4.5 Army casualties is missing, while only 1 out of every 49 Marine casualties is missing! The percentages quoted are based on present strength and would be lower in terms of total strength brought into Korea.

43. Army photo reconnaissance. On army's part, aerial photo reconnaissance, up to the time of this report, was consistently wasteful and uniformly nearly useless for army intelligence because of its small scale photos which could not show CCF personnel targets (see Annex 4). Furthermore, neither FEC nor EUSAK had brought needed army photo interpretation and photo reproduction units into the theatre, nor organized themselves to make effective use of planes and equipment available from Fifth Air Force.

44. The unexploited possibilities in aerial photo intelligence are discussed in detail in Annex 4. A single illustration will be given here. Photo mission No. 2168B

3/ Personnel Daily Summary; (Cumulative), 24 February 1951.

was flown north of Line Baker on 30 December 1950 at a scale of 1:7,500. Prints 90 to 20 in this series cover a line CT0107 to CT2710, which reference to Figure 1, Annex 1, shows to cross heavy CCF concentrations for a distance of about 16 miles. The USAF immediate photo intelligence report on these 70 prints gives: "Print 26:CT2710--2 U/I vehicles on road. Print 84:CT0507--Cart on secondary road." This brief report is consistent with AF mission to interdict transportation and supply. The following additional details, of interest to army, however, are evident in the photos and might have been exploited if army had provided the required PI and PR personnel and equipment. About 50 of the 70 photos show many miles of entrenchments. Many of these entrenchments are old, dating back to Soviet occupation of North Korea, and contain machine gun and mortar positions. More than half of the 50 trench photographs indicate stretches where the last snow of 20-21 December had been cleared out. Since cleared trenches in general were near Korean housing, and uncleared trenches were not, the inference is strong that CCF troops were making extensive use of the numerous Korean huts along this line (see also Appendix B, paragraphs 73-84 on CCF tactics). At the small scale of the photos, it was impossible to tell whether any CCF troops were in the trenches or using the huts. The photos also indicate that practically all artillery fires had fallen in unoccupied open fields and rice paddies since the last snow.

45. Enemy tactics and logistics. The tactics and logistics of enemy forces (described in Annex 1, paragraphs 12-17 and Appendix B, paragraphs 73-84) impede accurate estimates of enemy strength and deployment by ground sources, and make the efficiency and credibility low for visual observations from the air. In general, the bigger atomic troop targets have been enemy, and probably all of the attractive logistics targets have been friendly (see Appendix G on vulnerability of UN forces).

46. Communication monitoring. Enemy communications are relatively primitive. He uses almost no radio in combat areas and has very little wire, so monitoring and intercept have not been applicable except in his general headquarters areas. All attractive atomic targets which could have been developed by radio direction finding in Korea probably have been friendly (see Appendix G, Annex 2, on EUSAK and Fifth AF Headquarters vulnerability). On the other hand, enemy use of runners, and his issue of set instructions to field commanders from division level down has made the use of captured documents more attractive.

47. Prisoners of war. POW interrogations, always considered unreliable until verified by increasing numbers of

prisoners or by other information (see paragraph 17c, preceding) have been regarded as of low value in the Korean campaign because of general illiteracy and communist indoctrination of CCF and NKA troops. However, during November 1950 a deserter located the 66th CCF Army accurately enough to have made an atomic attack feasible (see Annex 2) and the impending CCF attack on Line Baker on 31 December 1950 was verified by several POW's (see Annex 1).

48. Line crossers. Low educational standards and language barriers have decreased the value of information from line crossers, refugees, and friendly local sources. They furnished trigger information on one occasion 4/ which additional reconnaissance could possibly have developed as a suitable target for atomic attack.

49. Minor operational and organizational deficiencies. Army intelligence in Korea has suffered from a few minor operational and organizational deficiencies. Each of these is trivial in itself, but taken in combination they can produce serious gaps in intelligence.

50. A substantial fraction of spot intelligence items and reports are vague on what was observed and how many were seen or suspected. This lack of definiteness is thought to be unnecessary and easily corrected. For example, a spot report will be specific with respect to time and place, yet fail to give even an upper or lower limit for the number of enemy troops observed. Consider a typical case from a spot report on enemy locations observed by patrols and by air (given in reverse order in time):

"a. Unknown number enemy CS502275 to CS520290 and at CS465245 during afternoon 27 January.

"b. 35 enemy vicinity CS545286 at 2712151.

"c. 30 enemy vicinity CS500273 at 2712001."

51. The use of three digit coordinates implies that locations are known to within about 100 meters. Item (a) defines an enemy line 2.3 kilometers long; taken together, items (a), (b), and (c) gives five points on an implied enemy line about 9 kilometers long. The inference from the reported times would seem to be that this line was probed during the afternoon after two enemy groups numbering 30 and 35 respectively were sighted about noon at points more than 4.5 kilometers apart. That is, items (b) and (c) are specific.

4/ Report of CCF Army (corps) near Kaesong, late December 1950.

and indicate that contact had been made with the enemy at noon. The rest of the afternoon's report, item (a), unfortunately becomes so vague that intelligence can infer at one extreme that two or perhaps three enemy platoons, total strength 60 to 100, are patrolling in the neighborhood, and at the other extreme, that contact has been made with an enemy division holding a line 9 kilometers long.

52. On some days up to half of the spot items may contain the stereotyped phrase "unknown number enemy";* yet time and coordinates rarely are reported less accurately than within one hour and 1,000 meters respectively. It should be made a rigid requirement that spot items give at least estimated upper and lower limits for troop numbers seen or suspected.

53. Another stereotyped intelligence phrase is "much enemy activity observed vicinity of ..." This could mean that three oxcarts have been sighted in a courtyard where there were none previously--or that there are strong indications that a CCF Army (corps) is billeted in the town. Unfortunately, the trite words "much enemy activity" have had the preceding range of meanings.

54. The remedy is obvious. Patrols, agents, and observers should be trained and instructed to report in the same brief, concise manner now used: (a) what was actually seen and the numbers seen; (b) and the observer's estimate, inference or suspicions, with stated upper and lower limits for numbers.

It is felt that procedures such as the preceding would prevent the probably false conclusion which can be drawn from GHQ Daily Intelligence Summaries, that troop densities in enemy-held territory average only 15 to 45 per square mile (see Annex 3).

55. Another weakness in present intelligence procedures is the frequent neglect of follow-up surveillance on definite contacts and on probable contacts indicated by trigger information. Closely related to, and possibly caused by, this neglect is the failure to indicate possible duplications (or lack of duplication) in troop sightings. Intelligence spot items and reports rarely indicate whether troops sighted one day either could or might be those reported previously, and vice versa. The effects are cumulative. Neglect of follow-up and failure to discriminate between duplicative and non-duplicative troop sightings leads to inaccurate or incorrect estimates of enemy strength

*For a 97-day period covering 3,081 cases, the number was reported as "unknown" in 1,434 cases, or 46%; see Annex 3.

and movement, and thence to failure to anticipate targets. It is true, of course, that order of battle intelligence at army or higher echelons does follow large scale enemy movements and trends. However, the enemy moves his forces piecemeal and frequently at night between assembly and concentration areas, with the result that intelligence contact on a CCF army (corps) of 30,000 men often is lost.

56. A further deficiency arises in routing and using available information. This has been more noticeable in photo intelligence. For example, the average time used in routing photo positives from JOC through EUSAK to I Corps during December 1950 was four days. A fuller discussion of lack of utilization of photo intelligence is given in Annex 4. Another symptom of poor utilization of available intelligence was the complaint by each of five regimental commanders polled that they believed they were left in unnecessary ignorance of the situation on their own fronts and on their flanks, with the result that both planned and automatic coordination were difficult at regimental levels.

57. In the field of counterintelligence, censorship has been lax on advance intelligence on the strengths, intentions, and movements of friendly forces. That is, there have been instances of a nearly one-to-one correspondence between newspaper reports and highly classified intelligence summaries in the Korean campaign with respect to units which had not yet made firm contact with the enemy. In the event of atomic warfare, the publication or misuse of privileged friendly information may be disastrous and therefore must be brought under greater control.

58. All of the preceding limitations and deficiencies will require improvement before atomic weapons can be used tactically with maximum effectiveness. Accuracy, speed and coordination in intelligence processes, both up and down the command ladder, will be required from theatre to regimental levels, particularly whenever atomic weapons are being used in close support.

SUMMARY

59. An examination of present methods and procedures in army intelligence indicates that these are not now adequate to permit efficient tactical use of atomic weapons, except near friendly lines in stabilized or quasi-stabilized situations. This appendix has suggested changes or improvements in methodology. Appendix D will discuss some of the possible organizational changes to improve the functioning of intelligence.

APPENDIX C, ANNEX 1:

VULNERABILITY TO ATOMIC ATTACKS OF THE CCF AND NKA FORCES DEPLOYED AGAINST THE STABILIZED LINE B (IMJIN RIVER, KOREA), 17-31 DECEMBER 1950

INTRODUCTION

1. Previous studies have applied atomic weapon effects to various World War II situations. Necessarily, the historical accumulation of data was quite broad and the analysis therefore rather shallow in scope, although it was useful to outline the general trends of such possible employment of atomic weapons.

2. The need was great for a detailed breakdown of a military deployment into small units, accurately located and identified, and for a careful application of known atomic weapons effects to such deployment. The Korean conflict afforded such an opportunity for analysis teams to be present in the combat zone at specific times and places so that data could be obtained in person and from military personnel in the field before, during and after some important war situations.

3. The atomic weapons effects discussed in detail in Appendix A will be drawn upon heavily, in particular the effects of a 40 KT atomic bomb burst about 3,500 feet in the air. In brief, the physical effects will extend to a distance from ground zero of about 5 kilometers or about 5,500 yards on a clear day of about 12 miles visibility. Considerations of accuracy of delivery by aircraft which have a visual CPE of about 500 yards will add one CPE radius and make the safe distance of the aiming point from friendly troops about 5½ kilometers or approximately 6,000 yards.

4. The withdrawal of UN Forces from North Korea to positions on Line B, just north of Seoul and roughly along the 38th Parallel, was followed by a period of about two weeks, from 17 December to 31 December 1950, during which this front remained stabilized. There was relatively little contact with the enemy who gradually assembled their offensive forces preparatory to assaulting this position. The first strong probing attacks began before midnight on 31 December 1950. The

enemy penetrated this line in force during the night and eventually caused another withdrawal to positions farther south along a Line C. A detailed study of the enemy movements, strengths, and locations during this period was made from information gathered from intelligence and operations sections at army and corps levels in Korea. The data were then used to evaluate the effects on such forces in the field of employment of atomic weapons. All available details of combat intelligence and operations were used to make estimates of the presence and locations by map coordinates of personnel and materiel down to individuals or squads and mortar and gun emplacements as well as animals and tanks.

SOURCES OF INFORMATION

5. At corps level the material gathered by G-2 and used in this study consisted of the following types of information:

a. Spot Reports, containing the immediate reports of intelligence items, received by telephone, written reports from other sources, reports from clandestine agents and line-crossers, and airplane detection. These items are immediately copied and transmitted to other corps and army headquarters.

b. Collation File, which is a working paper summarizing in brief form the essential data from the spot reports.

c. PIR, daily periodic intelligence report which is issued by the plans and analysis section of G-2 and describes the daily G-2 estimate of the situation facing the corps.

d. Isums, or intelligence summaries, which periodically discuss the over-all situation.

6. At Eighth Army Headquarters (EUSAK) extensive use was made of the spot reports, the EUSAK PIR, the G-2 and G-3 daily overlays of the enemy and UN forces deployed in the field, and daily briefing by members of the G-2 and G-3 staff. The latter is summarized in briefing notes issued daily with the overlays.

7. The specific items of information gathered from all the preceding sources were placed as accurately as possible by map coordinates on an overlay on a 1:50,000 scale map of the regions of Korea just north and south of the 38th Parallel where the B line of defense was placed roughly 30 miles north

of Seoul. The UN lines remained in this approximate position for at least two weeks until the enemy penetration on the night of 31 December 1950-1 January 1951.

LIMITATIONS AND EVALUATION OF INFORMATION

8. This information accumulated by G-2 in Korea suffers from the limitations discussed in Appendix C, and evaluation of the information and its sources becomes an absolute necessity.

9. In general, it is not single items but the careful scrutiny of the whole series of items that may build up a general picture of the deployment and the movement of enemy forces. This screening or evaluation takes the form of assigning a symbol-evaluation of contact and information which moves higher up the scale as confirming evidence appears.

Table I shows the terms and symbols used in EUSAK and corps evaluation scales.

TABLE I

SYMBOL-EVALUATION OF CONTACT AND INFORMATION

Evaluation as to Source	Evaluation as to Truth, Credibility, or Probability
A - completely reliable	1. Report confirmed by other agencies
B - usually reliable	2. Probably true report
C - fairly reliable	3. Possibly true report
D - not usually reliable	4. Doubtfully true report
E - unreliable	5. Improbable report
F - reliability cannot be judged	6. Truth cannot be judged

10. Where time is not a critical factor this screening and evaluation process may succeed in identifying the over-all forces in a large area and may give a fairly good estimate of small units. Line B was stabilized for more than two weeks and therefore it afforded considerable time for building a picture of the opposing forces and the specific areas of many units. The over-all G-2 estimate of this situation may reasonably achieve a B-2 rating in the aggregate.

11. All spot items have been studied for the period of 17-31 December 1950 and all have been placed on the map of the area (see Figure 1, envelope inside back cover) together with the date of the spot. This accumulation of spot reports for the entire two-week period is presumed to represent a fair picture of the over-all enemy build-up. The accumulations so made in front of I Corps and IX Corps do come close, as described below, to the over-all G-2 estimates of total forces facing these corps on 31 December 1950.

CHARACTERISTICS OF ENEMY TACTICS AND MOVEMENTS

12. A brief description of the tactics and movements of the enemy forces will indicate the problems of intelligence in obtaining information reliable enough to influence military action.

The CCF soldier usually travels at night, mostly on foot, carrying (on his back, or by horse or pack animal) the supplies and ammunition he may require, probably only a 3-7 days' supply. During the day he generally goes into cover, foxholes or other type, frequently covering the opening with rice sacks which blend with the earth and impede observation from the air.* When he travels, he often follows less frequently used roads, and even goes around the hills and mountains along stream beds and poorly marked trails. Camouflage and infiltration have been developed to an effective degree and permit surprise, envelopment, ambush, and the cutting of vital supply and communication links.

13. The Korean terrain, being mountainous, is rough and difficult to traverse. It contains numerous channels through which small groups may pass almost undetected to assembly points elsewhere. It may probably be true that there are no other exactly similar terrain features anywhere in vital world regions to which the particular tactics and training of the present enemy forces are so well adapted. But UN forces might well consider the lessons learned from the CCF in the Korean area for the possible future necessity of operations in other countries ~~not too dissimilar~~ in terrain, i.e., Turkey, Spain, and the Balkan nations. Infiltration in small numbers and the formation of guerrilla bands behind the lines is facilitated by such terrain. Intelligence must cope with unseen or poorly seen enemy groups traveling at night, carrying their supplies on their backs, and hiding from air attack and detection by day.

14. The subject of terrain as it exists in Korea and as it affects the employment of atomic weapons is described

*This cover is crude and detectable. See para. 47, Annex 4.

in detail in Appendix A and illustrated in Figures 9 and 10. These figures show graphically that in many regions of interest the hills are on the average of 300-400 meters high with the higher hills of the order of 1000-1200 meters in height. Furthermore, from the point of view of atomic weapon effects, large open areas exist which are equal to or larger than the weapon damage area. Inspection of air reconnaissance photography 1/ of the region fronting I and IX Corps north of Line B shows many long trench lines, generally running near the tops of the hills or below the crests. A burst height of about 3,500 feet would have been very effective in clearing all hills in the areas chosen and would have washed down the hills and surrounding terrain with the atomic weapon effects of blast pressures, thermal and nuclear radiation, essentially to the extremes of the physical damage distance of about 5,500 yards for a 40 KT atomic bomb burst on a clear day. Details of selection of aiming points, and the assessment of personnel damages are described fully in the following sections.

15. It can safely be concluded from inspection of the figures and photographs of the terrain that, subject to proper selection of burst height, aiming points, and other relevant information, the terrain in Korea in the areas studied would not be an obstacle to effective use of atomic bombs.

16. Apparently there is some tendency for the enemy forces to stop their activity, for reassembly and reformation, when their immediate store of supplies is consumed. They take their time in assembling forces considered adequate for an attack and are adept at probing the lines and finding weak points.

17. In terrain other than Korea the CCF and NKA forces would very likely lose much of their effectiveness and prove a more ordinary foe becoming more subject to their inadequacy of arms and air support. In Korea, the fighting is definitely on terms most favorable to an enemy trained for exactly this type of terrain and this type of warfare.

BUILD-UP AND DISTRIBUTION OF ENEMY AND UN FORCES BEFORE THE STABILIZED LINE B (IMJIN RIVER), 17-31 DECEMBER 1950

18. Figure 1 shows the build-up in the period 17-31 December 1950 and distribution of enemy and UN forces before the stabilized Line B up to the time roughly between 2100 and 2400 hours, 31 December 1950 when the first enemy

1/ Photo mission No. 2168B of 30 December 1950; target No. Z-1404.

units penetrated the line between the 11th and 12th ROK regiments of I Corps. For this period, all spot reports of enemy units, materiel, and animals in the enemy region (varying from 20 miles from the left flank of I Corps to about 12 miles from the right flank of IX Corps) are indicated in the figure. The positions of the bomb line, the UN forces, and the boundaries between UN forces are also shown in exact positions according to best known map coordinates. For most of the length of front line between I Corps and the enemy forces, the Imjin River formed a natural boundary approximately 300-400 yards wide on the average, being wider and unfrozen at the western end, where also the terrain was too difficult to afford easy crossing; the river was narrower and frozen over at the eastern end of the I Corps line, where the 11th and 12th ROK Regiments were deployed and where in fact the first enemy penetration occurred.

19. The enemy spot items in Figure 1 represent accumulated reports for the entire period from the 17 to 31 December. This necessarily means that some of the items have been reported more than once, since a first spot report of a unit strength and location makes subsequent detection relatively easier. Items also have been included which vary considerably in symbol-evaluation rating. In addition, items reported early in the two-week period do not necessarily remain in the position reported, despite the stabilized nature of the line, but continue to move elsewhere. However, the general movement was southward to assembly points in front of Line B, and it is felt that the reporting of any unit within a distance of 15-20 miles from the I Corps and IX Corps front line forces will represent a unit that was probably present in the enemy force assembled for assault on Line B the night of 31 December. It is felt further that any duplication of reporting of units was more than compensated by the fact that the intelligence return in accumulated total spot reports probably represented a major fraction of the total force actually present. Consequently, this duplication will not, in such a problem as this, be of great importance. A comparison of the total accumulated force obtained by counting in Figure 1 the spot items opposite I and IX Corps will be made below with the over-all G-2 estimate of the total enemy forces believed to be present on 31 December 1950.

20. The information is most comprehensive in front of I and IX Corps and attention will be restricted mainly to the enemy massed in front of these sectors. The activity here during the period discussed was greater than in other sectors farther east where terrain and winter hampered enemy troop and supply movements. The UN forces in the I and IX

Corps were made up of the units shown in Table II.

TABLE II

FRIENDLY FORCES OPPOSING THE ENEMY ON LINE B

I Corps	IX Corps
25th Division (24th, 35th, 27th Regiments)	24th Division (5th, 19th, 21st Regiments)
29th British Brigade	1st Cavalry Division (5th, 7th, 8th Regiments)
1st ROK Division (11th, 12th, 15th Regiments)	27th British Brigade
Turkish Brigade	6th ROK Division (2nd, 17th, 19th Regiments)

21. The enemy front lines in 31 December 1950 may be given by the following map coordinates as seen also from Figure 1: BS9995, CS0098, CT0505, CT1102, CT1802, CT1909, CT2109, CT3010, CT4010, CT5108, CT5608, CT6610, CT7506, CT8507, CT9208, DT0608, DT1203, DS2295, DS3195, DS4098, DS4583.

22. The weather on 31 December 1950 was clear until 1100, becoming cloudy with scattered low clouds whose bases were at 4,500 feet altitude by 1430 hours. The visibility was 5 miles at 0700 hours becoming 8-10 miles by 1200 hours. There was no precipitation. On 30 December 1950 the visibility was better than 8 miles with no precipitation. On 1 January 1951 the visibility was clear, being somewhat hazier in the morning and improving to about 7 miles or better by 1030 to the end of the day. For the purpose of this study it may be assumed that the weather condition was clear. Hence, the atomic bomb damage criterion for a clear day (attenuation coefficient 0.2 per kilometer) may be used to determine the effects of employing a 40 KT atomic bomb at a height of burst of about 3,500 feet above the enemy forces on the night of 31 December 1950.

23. A copy of EUSAK Periodic Intelligence Report No. 172 for the period 302400-312400 December 1950 is appended for reference and for a general description of the situation. (See Inclosure A to this Annex.)

24. Tables of organization and strength, based on the interrogation of more than 133 CCF prisoners of war captured from elements of the 38th, 39th, 40th, 42nd, 50th, and 66th CCF armies, have been drawn by the EUSAK G-2 staff and are

considered to give good agreement with information from various other sources. Prisoners of war are generally in agreement that the CCF infantry regiment is composed of three battalions with estimated strengths of 700 men each, and further that the battalion is divided into three infantry companies and one heavy weapons company. To date, reports of the artillery units in the CCF are rather indefinite. However, POW's claim that the basic artillery support for the CCF infantry regiment would be an artillery battery, and that the CCF army group support consists of one artillery division. Because reports vary, no attempt is made to denote either the calibre or size of enemy weapons, chiefly US arms captured from Chinese Nationalist units, Japanese weapons, and also Russian weapons. Table III and the accompanying organization chart summarize the estimated strengths and organization of CCF units

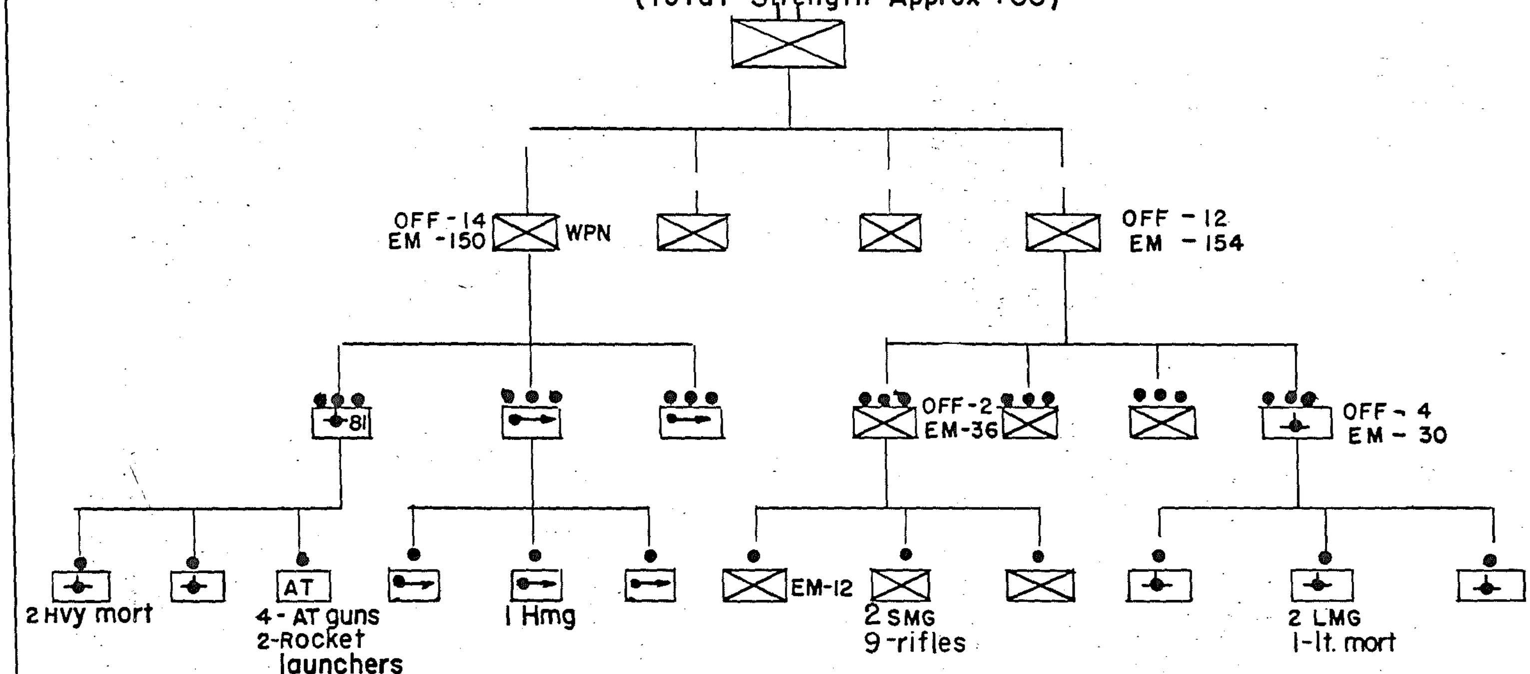
TABLE III

STRENGTHS AND WEAPONS IN CCF UNITS

Unit & (Approx. Strength)	SMG	M G		Mortars		AT Weapons	
		Lt	Hvy	60mm	81mm	Rocket Launcher	37mm Guns
Rifle regt (2,800)	162	54	18	81	12	6	12
Wpn bn 1/ (700)		54	18	81	12	6	12
Rifle bn (700)	54	18	6	27	4	2	4
Wpn co 2/ (160)	--	18	6	27	4	2	4
Rifle co (166)	18	6	--	9	--	--	--
60mm mortar & MG platoon (34)	--	6	--	3	--	--	--
Rifle plat (38)	6	2	--	--	--	--	--

1/ Attached from division.
2/ Attached from weapons battalion

ORGANIZATION AND STRENGTH OF CCF UNITS (BN)
(Total Strength Approx 700)



NOTE: DUE TO THE DISCREPANCY IN MODELS, NO ATTEMPT HAS BEEN MADE TO DISTINGUISH BETWEEN CALIBRE OF WEAPONS.

THIS CHART HAS BEEN COMPILED THROUGH STATEMENTS OF POW'S. SOME FIGURES HAVE BEEN INTERPOLATED

APPENDIX C, ANNEX I

COMPARISON OF CUMULATIVE SPOT COUNT IN PERIOD 17-31 DECEMBER 1950 WITH OVER-ALL INTELLIGENCE ESTIMATES

25. Figure 2 (see envelope, inside back cover) shows an overlay on a map of the over-all G-2 estimate of enemy forces facing the UN forces on 31 December 1950. It indicates a total of about 174,000 CCF troops, and about 73,800 NKA troops, representing about 6 CCF armies believed to be the 38th, 39th, 40th, 42nd, 50th and 66th CCF Armies, and about the equivalent of two NK armies, deployed to a depth varying between 20 and 40 miles against the UN forces on Line B. On the line, the 50th CCF army occupied a position roughly in the vicinity of Kaesong opposite the left flank of I Corps, the 39th CCF Army opposite the right flank of I Corps, the 38th CCF army opposite the left flank of IX Corps, the 66th CCF army tentatively located opposite the right flank of IX Corps and the left flank of III ROK Corps. In addition, some 20,000 NKA troops were in the line opposite I Corps, about 5,500 were opposite IX Corps, and some 43,000 troops and guerrillas were opposite the III ROK Corps sector. Immediately behind these forces, acting as reserves, the 40th CCF army together with some NKA troops were deployed behind the 38th and 39th armies opposite I and IX Corps, while the 42nd CCF army and NKA troops were in similar position roughly opposite the IX Corps and III ROK Corps sectors.

26. The total forces opposite Line B were of the order of about 250,000 men, of which about 80,000 were roughly deployed against the I Corps line and about 35,000 against the IX Corps line. This may be compared with the total forces against the Corps lines obtained by counting on Figure 1 the accumulation of spot items for the period of 17-31 December 1950. In the region of Figure 1, lying in a depth of enemy territory approximately 10-15 miles deep, the spot count gave about 76,500 against the I Corps sector and about 35,500 against the IX Corps sector. These figures compare extremely well with the over-all estimates of line forces shown in Figure 2 and discussed previously. All numbers are, of course, necessarily approximate. From Figure 1 we can see that the bulk of the 112,000 men counted by the spot report method will be deployed in an area roughly 30 miles long by 6 miles deep or about 180 square miles, giving an average density of about 622 men per square mile. However, closer examination of the concentrations of enemy forces by spot counts on Figure 1 will show that several areas exist in which the concentration will vary between 330 and 500 men per square mile. This will be discussed in detail following, where the effects of using atomic bombs will be described. Figure 2 also indicates the presence of additional enemy forces farther north and generally moving south.

27. The method of accumulating spot reports in this example of stabilization and build-up for mass attack gives results of enemy strength which are approximately equal to those obtained by over-all intelligence estimates. There is a high degree of probability that the accumulation method will give results more quickly although it must be subjected to additional tests of similar situations in order to determine its accuracy and validity.

TIME FACTORS IN DECISION AND CHOICE OF BEST TIME OF DELIVERY

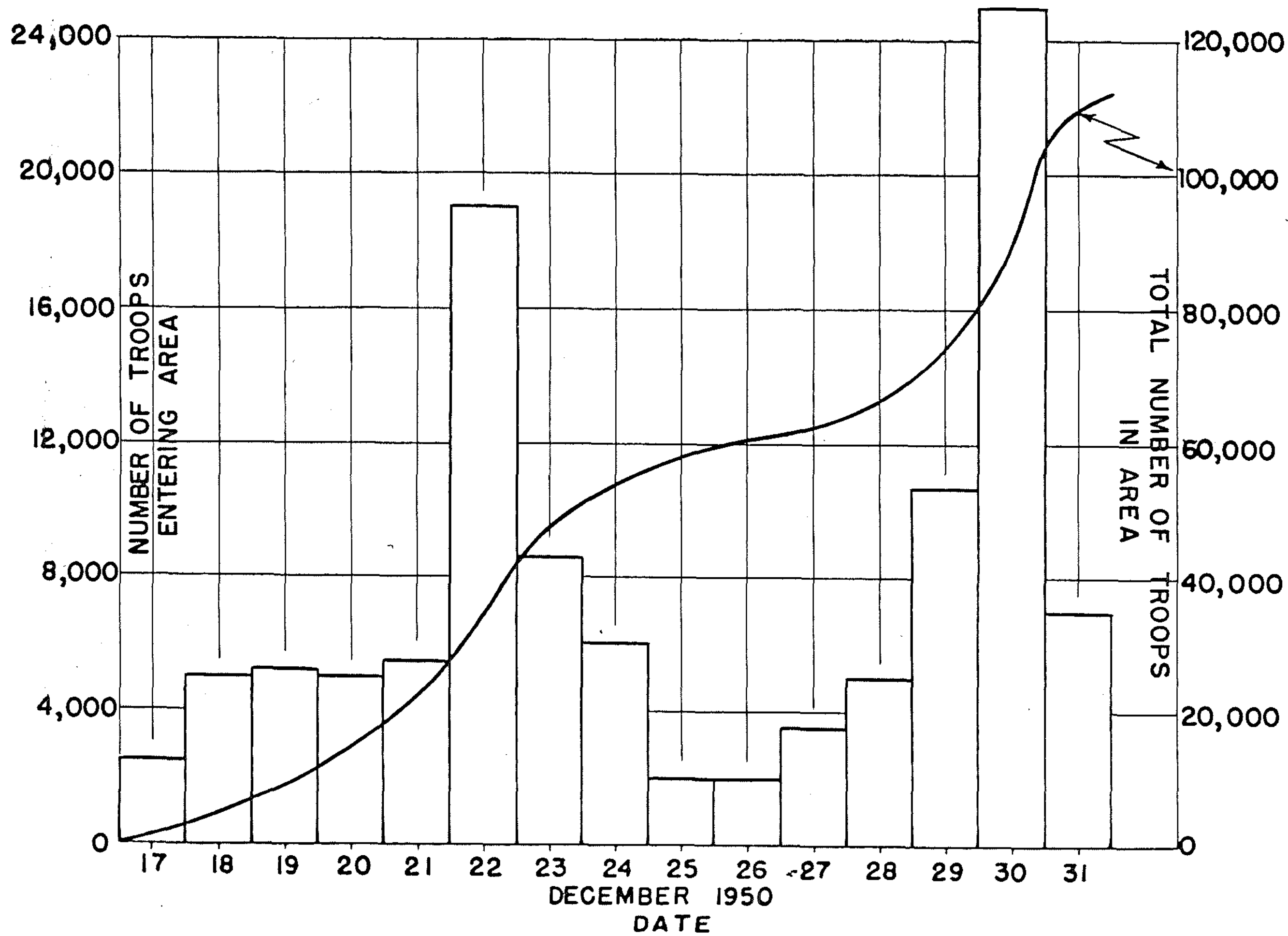
28. On the night of 29 December 1950 the evaluation of the over-all enemy situation indicated that the enemy was probably not ready for the attack on Line B but apparently was very rapidly approaching the necessary degree of readiness. It was estimated that the attack could be expected any time within 48 hours thereafter, with the more prevalent predictions centered around the night of 31 December 1950. POW interrogations indicated also that the attack on Line B was planned for some time in the early morning of 1 January 1951. Numerous personal wagers were placed on the exact hour on the night of 31 December 1950 when the attack could be expected.

29. The preceding evaluations of the extent of the enemy build-up and the probable time of the attack were obtained by daily study by G-2 staff members of the spot reports and by estimated judgments of the over-all picture from the additional information gathered from POW's, line-crossers, and airplane visual detection. In Figure 3 is presented a possible method for obtaining graphic evidence of such a build-up and specific information leading to a definite determination of the most probable time of enemy attack. The data from Figure 1 have been plotted to show the numbers of troops entering areas fronting I and IX Corps each day of the period 17-31 December 1950, and also the total number of troops present in these areas at the end of each day. It is very clear that a large build-up took place between 17-25 December, with the greatest number entering the area around 22 December. The total enemy forces accumulated in this period amounted to about 55,000 men. This number obviously was not sufficiently large nor properly deployed to undertake a successful offensive against the UN defensive forces deployed on Line B. In the period 25-31 December there was a second large build-up. The greatest number entered the area on 30 December, raising the total enemy forces in the area to about double the total assembled during the first period.

30. Inspection of Figure 3 shows that ending 30 December the total enemy build-up was in sufficient strength

Fig. 3, Appendix C, Annex I

BUILD-UP OF CCF AND NKA FORCES BEFORE THE STABILIZED LINE B (IMJIN RIVER) 17-31 DECEMBER 1950 OBTAINED FROM THE ACCUMULATED SPOT REPORTS FOR THE PERIOD



to undertake an offensive, and that attack could be expected at any time thereafter. The enemy forces reached their maximum concentration in preparation for attack by bringing about 25,000 additional troops into the area on 30 December. Since the tendency of both CCF and NKA forces is to move or attack at night, the night of 31 December 1950-1 January 1951 is clearly indicated by Figure 3, as the probable time to expect the offensive.

31. This interpretation permits decision to use atomic bombs, and to effect delivery at or close to the start of the offensive in order to maximize the number of enemy troops out of cover and moving in the open. Assuming that atomic weapons were available in the FEC, perhaps in Japan or Okinawa, both about 5 hours flying time from Korea, and that the necessary aircraft and weapon facilities were alerted, approximately half a day would have been sufficient for request and delivery by air of atomic bombs from air base to target.

32. It is therefore suggested that the decision to use atomic bombs in the situation described could have best been made on 30 December 1950, and the time of delivery set for about 2300 on the night of 31 December 1950. This action will be assumed in the following section in which the effects of 40 KT atomic bombs exploded 3,500 feet in the air will be described. Figure 1 shows that by midnight of 31 December enemy troops in about division strength had penetrated Line B between the 11th and 12th ROK Regiments of I Corps. The massed enemy forces behind this spearhead were essentially in the open and on the move. It is these latter concentrations of enemy forces which will be considered the primary target for atomic bombs.

EFFECTS OF EMPLOYMENT OF ATOMIC WEAPONS ON THE NIGHT OF 31 DECEMBER 1950

33. The effects of a 40 KT atomic weapon described in detail in Appendix A of this report may be used to estimate the fraction of total troops who may become casualties within a vulnerable area. Thus the physical limit from ground zero beyond which no casualties may be expected is approximately 5,500 yards, or 5 kilometers. Addition of twice the CPE of delivery, given by a visual bombing CPE of 500 yards, will make the safety limit to friendly troops about 6,500 yards, or 6 kilometers from the aiming point for a 40 KT air burst. Actually 1 CPE gives good safety (Appendix B).

34. Figure 1 shows six concentrations which were considered possible targets for atomic bombs. Circles of 5 and 6 kilometer radius are drawn around the selected aiming

points. They show the vulnerable area, the safety area to friendly troops, and the inclosed enemy forces subject to the effects of six atomic bombs. Table IV summarizes the location, friendly units opposed, density and total number of enemy troops in the vulnerable area, and the total number of enemy casualties estimated.

TABLE IV

EFFECTS OF EXPLODING 40 KT ATOMIC BOMBS 3,500 FEET IN THE AIR ON A CLEAR DAY OVER CHOSEN AIMING POINTS ON ENEMY FORCES FACING LINE B ON 31 December 1950

Aiming Point	UN Regt Opposed	Number of Enemy in Area: Total (No/mi^2)	Casualties	Remarks
1. BS964983	24th Regt (25th Div, I Corps)	10,000 (330)	4,000	These forces are blocked from UN forces by very difficult terrain
2. CT045045	35th Regt (25th Div, I Corps) & 11th Regt (1st ROK Div, I Corps)	10,000 (330)	3,850	Many pack animals, vehicles, mortars also affected materially
3. CT120110	11th Regt (1st ROK Div, I Corps)	15,000 (500)	6,000	40 field pieces, many vehicles, mortars, 2 supply points included and materially affected
4. CT214132	12th Regt (1st ROK Div, I Corps)	11,000 (370)	4,000	Many field pieces, vehicles mortars, some tanks, animals, some pillboxes
5. CT310140	7th & 19th Regts (6th ROK Div, IX Corps)	12,000 (400)	5,000	Several tanks and field pieces

(Table IV Continued)

Aiming Point	UN Regt Opposed	Number of Enemy in Area Total (No/mi^2)	Casualties	Remarks
6. CT403125	19th Regt (24th Div, IX Corps)	14,000 (470)	6,000	3 supply points, many trucks, animals, mortars

35. The total number of enemy troops in the six selected areas indicated in Table IV is about 72,000 men of which approximately 28,850, or 40 percent, would have been expected casualties from the use of six 40 KT atomic bombs. Of these casualties, roughly half would have been deaths and the other half seriously injured and removed from any tactical use for varying periods of time.

36. Essentially, the attacking 38th and 39th CCF Armies would have been units hardest hit by the six bombs used at the locations selected. Only a few units of the 50th and 66th CCF Armies in the front line facing Line B, and very few units of those in close reserve, the 40th and 42nd CCF Armies, would have been affected. In the stabilized situation existing during the period described, additional bombs used in the rear of the front line forces would have been able to inflict major damage to the 40th and 42nd CCF Armies which were deployed directly behind the front line armies. Other reserve forces farther north would likewise have been vulnerable to atomic bomb attack.

37. In a similar manner, other lines or positions may be analyzed, since concentration and assembly of forces normally occur preparatory to an attack on any line. Withdrawal of UN forces, frequently by motorized means, in contrast to NKA and CCF advances, usually on foot, also helps to create a new line requiring new enemy reorganization and assembly. Situations as readily available to analysis may have been present in January 1951 when the UN forces withdrew to Line C, and later to Line D. The preceding analysis will serve to outline the effects of atomic weapons in all such stabilized conditions, provided the data and information are available and quickly accessible. The present study also indicates that adequate information can be obtained near stable lines and, with relatively little additional effort, can easily provide the means for a continuous atomic target analysis. Close coordination of analysis groups in and with the G-2 and G-3 sections during build-up and attack with on-the-spot analysis, would provide training for future use of atomic weapons.

MILITARY IMPLICATIONS OF EFFECTIVENESS AGAINST ENEMY OFFENSIVE FORCES FRONTING A STABILIZED LINE

38. The preceding discussion of the effects of employing atomic bombs against CCF and NKA forces opposing a relatively stabilized line emphasizes the magnitude of the destruction inflicted. It is undoubtedly true that a depletion of force by about 40 percent through such means would have crippled the enemy and destroyed for a considerable period of time his offensive effectiveness against the UN forces. The study of terrain and its relationship to the height of burst and damage area have shown that even under Korean terrain conditions, atomic weapon characteristics are of such magnitude that these difficulties are surmounted with relative ease. It is apparent therefore that atomic weapons can become decisive tactical weapons for the support of ground operations in any theatre.

39. A stabilized condition similar to the one discussed here can be created by various means well known to field commanders, if a stable situation does not already exist. These means include rapid withdrawal to prepared lines, counterattacks followed by digging-in or withdrawal, and the use of land mine fields or natural barriers. The elements of importance in creating or exploiting such situations for atomic attack include recognition of the development or existence of targets, intelligence evaluation of the strengths, locations, densities and time of existence of targets, and the making and timing of decisions for use and delivery of atomic bombs. Target recognition and evaluation can enter planning and execution stages only: (1) if the weapons are available in the theatre; (2) if their effects and employment criteria are understood by field commanders; (3) if technical advisers are present in the theatre; (4) if the total time required for target evaluation, command decision, and bomb delivery are less than the time in which the target may dissipate; and (5) if friendly forces are indoctrinated in defense against and exploitation of atomic weapon effects.

40. The use of atomic bombs against front line forces can be disastrous to these forces. Likewise, their use against reserve forces, in bivouac or assembly areas, can be equally effective if the intelligence on their existence and location is adequate. If surprise in planning and executing atomic attack is achieved, decisive results can be obtained, despite the efforts of the enemy to adopt evasive and preventive tactics. This would be very likely to force him into unfamiliar tactics unfavorable to his use of massive assault against prepared positions.

APPENDIX C

REQUIREMENTS FOR INCREASING INTELLIGENCE INFORMATION AND ACCURACY FOR ATOMIC WARFARE

41. It is obvious that a main element in the successful use of atomic weapons will be intelligence prodedures to provide adequate information as to numbers, locations, and times of existence of enemy targets. The method of mapping concentrations by accumulations from spot reports, shown in Figure 1, supplemented by graphic representation of total enemy build-up, shown in Figure 3, provides means for accomplishing this. If done continuously by days and by periods as used here, the over-all situation with respect to atomic targets may be evaluated at any time. At present this is being partially accomplished in the field at corps and army levels only for quasi-stable situations close to friendly lines. (January 1951)

APPENDIX C, ANNEX 1

INCLOSURE A

EUSAK
APO 301
312400 December 1950

Periodic Intelligence Report No. 172

Period Covered: 302400 - 312400 December 1950

Maps: AMSL 551 Korea 1:250,000

1. ENEMY SITUATION AT END OF PERIOD

a. See accompanying map. see envelope back cover

b. Enemy Front Lines - BS9995, CS0098, DT0505, CT1102, CT1802, CT1909, CT2109, CT3010, CT4010, CT5108, CT5608, CT6610, CT7506, CT8507, CT9208, DT0608, DT1203, DS2295, DS3195, DS4098, DS4583.

2. ENEMY OPERATIONS DURING PERIOD

a. Summary - In the US I Corps Sector an estimated enemy regiment was reported to have crossed the IMJIN River to the south and launched a strong attack supported by artillery fire against friendly positions on the right flank, making a limited penetration which was reportedly contained by friendly forces at close of period. In the US IX Corps sector an unknown number of enemy launched several probing attacks against friendly positions and succeeded in making a limited penetration to vicinity CT3906 during the period. In the ROK III Corps sector enemy of unknown strength launched probing attacks against elements of the left flank, with no reported results. Friendly air and police reported sizeable enemy troop concentrations in the friendly rear areas. In the ROK I Corps: An estimated enemy division and a reinforced enemy regiment plus an unknown number of guerrilla elements were reported by ground forces during the period.

b. New Tactics and Weapons or Other Material - Negative

c. Operation of Enemy Component Elements

(1) Air Force--An unidentified aircraft dropped a flare vicinity CT4003 at 312047.

(2) Administrative Units--Negative.

(3) Anti-tank Units--Negative.

(4) Anti-aircraft Defenses--Friendly air reported receiving heavy flak vicinity BT6717 at 310432.

(5) Armored and Motorized Units--Friendly air reported the following: Observed 7 enemy vehicles moving northwest vicinity CT7488 and 12 enemy vehicles moving southeast vicinity CT8278 at 310025; attacked a convoy of 25-30 enemy vehicles moving south vicinity YD5384 damaging 3 at 310350; attacked unknown number of enemy vehicles vicinity CT6840, and CT8051 at 310442; attacked 40 enemy vehicles moving south between Pyongyang and Sariwon and attacked 40 enemy vehicles moving south between Huichon and Anju at 310145; observed 30-40 enemy vehicles moving northeast vicinity DT4935 and observed 10 enemy vehicles moving north vicinity DT3271 at 310229; observed 20-30 enemy vehicles moving southeast vicinity DT7000 and 25 enemy vehicles moving southeast vicinity CT8015 at 310325; destroyed 9 enemy vehicles vicinity BV4815 at 310445; attacked 4-5 enemy vehicles vicinity CU5350 with unknown results at 310656; destroyed 1 enemy tank vicinity CT1508 at 301625 (delayed report); attacked 1 enemy tank vicinity CT2622 at 311130 and destroyed 3 enemy trucks under bridge vicinity BT8179 at 311830; observed 25 enemy vehicles moving east from Yonan BS5099 at 311258; attacked 5-10 camouflaged enemy vehicles vicinity CT2225 at 311814 and observed 75-100 enemy vehicles moving south from Sinanju to Pyongyang at 312140; attacked 10 convoys of 5-10 enemy vehicles each and 75 single enemy vehicles moving south between Kunu-ri and Pyongyang at 312320.

(6) Artillery--Friendly air reported attacking 3 SP guns vicinity CT1508 at 301645. High velocity SP gun fire was received by elements of the 17th FA Battalion vicinity CT1802 at 311800. Unknown number of artillery rounds were received by elements of the 1st ROK Division at 311830. Estimated 30 rounds of light artillery was received by elements of the 31st ROK Regiment at 311930.

(7) Engineers--Friendly air reported an enemy road block consisting of rows of angle-iron across the road vicinity CT3333 at 311130. The following information was furnished by A-2, South Korean Air Forces: On 3 August 1950 the 3d Division, North Korean People's Army (In Min Gun) commenced construction of an underwater bridge near Waegwan,

South Korea. This bridge was to be constructed to avoid possible air sightings of the bridge and to speed up the advance of enemy troops across the Naktong River at this area. Approximately two thousand five hundred (2,500) local inhabitants were mobilized by the enemy troops and work began. A total of three (3) bridges were built side by side at this area. Two (2) of the bridges were built for troop crossings only while the third was built for vehicles and heavy equipment. The construction of these bridges took approximately six (6) days to complete. An average of forty-eight (48) hours was taken to complete each of the three (3) bridges. Upon completion of construction of these bridges, infantry personnel of the 3d Division and the Division artillery crossed the river immediately. Lumber and sandbags comprised the construction of the bridges. Each of the three (3) bridges were approximately one-hundred sixty (160) meters long, and were erected at a distance of seven (7) meters between each bridge. The width of each bridge was five (5) meters. Approximately two thousand eight hundred (2,800) sandbags and seven hundred (700) railroad ties were used for each bridge. The water reached a depth of three (3) meters and forty (40) centimeters in the deepest portion of the river. The bridges were constructed approximately twenty-five (25) centimeters under the surface of the water. (Further details unknown)

(8) Infantry--An estimated 800-1000 enemy following stream beds to Nonsang-ni BS9996 then proceeding to Tongjong-ni BS9796 on 28 December, and estimated 1000 enemy vicinity BS9997 on 29 December observed by agent (delayed report). An estimated 100 enemy in groups of 20 observed by agent passing along road enroute to Changdan CT0301 between 282000 and 290400 (delayed report). Friendly air reported the following: Observed an unknown number of enemy troops in Kumchon BT7925 and an estimated 200 enemy vicinity Tongjong-ni BS9797 at 310915; attacked an estimated 400 enemy moving south and southeast out of Kaesong at 311200. An estimated enemy company vicinity CT1505, an estimated enemy platoon vicinity CT1506, an estimated enemy company vicinity CT1406, an estimated two enemy companies vicinity CT1407 and an estimated enemy battalion vicinity CT1206 reported to have forced friendly patrols and outposts to withdraw to the south side of the Imjin River during the night 30-31 December. An unknown number of enemy troops vicinity CT1508 and an unknown number of troops on ridge vicinity CT1211 were attacked by friendly air on 31 December. An estimated 200 enemy vicinity CT1405 were encountered by two companies of the 11th ROK Regiment at 311300 and a fire fight followed with the enemy reported using hand grenades only. At 131530 the enemy withdrew slightly to high ground where they were subsequently

reinforced by an estimated enemy company from vicinity CT1307 forcing friendly forces to withdraw to better defensive positions where the fighting continued until 311930 at which time friendly forces disengaged and withdrew south of the Imjin River.

An estimated enemy company with small arms, automatic weapons and mortars on Hill 87 CT1507 halted the advance of a company of the 11th ROK Regiment at 311300. A large enemy concentration vicinity Hill 91 CT1206, 3 enemy mortars and 8 machine guns vicinity CT1807 and 2 enemy mortars vicinity CT1206 reported by patrols of the 1st ROK Division on afternoon 31 December.

Enemy elements were reported by elements of the 1st ROK Division to have crossed the frozen Imjin River at 311830, with an estimated enemy company crossing vicinity CT1705 and an estimated enemy battalion crossing vicinity CT1905. An estimated enemy company crossed the Imjin River vicinity CT2208 at 311830 and attacked elements of the 12th ROK Regiment forcing friendly forces to withdraw to vicinity CT2207 where the enemy attack was reportedly contained as of 312030. The estimated enemy battalion vicinity CT1905 continued to be reinforced by enemy crossing the river, this enemy force increased to an estimated 2 enemy battalions and attacked elements of the 15th ROK Regiment forcing a penetration to vicinity CT1701, where enemy attack was contained by friendly reserve elements, however this enemy continued to probe for weak spots in the new friendly line vicinity CT1602, CT1701 and CT2001.

At 312400 situation was reported quiet and under control by friendly forces. An estimated enemy battalion attempting a river crossing vicinity CS0010 was repulsed by elements of the ROK Division at 312200. An estimated enemy platoon dug in vicinity CT3612 and an estimated enemy platoon dug in vicinity CT3611 reported by patrols of 6th ROK Division on 31 December. An unknown number of enemy crossing the river vicinity CT2808 reported by elements of 6th ROK Division at 312300. An unknown number of enemy moving south vicinity CT3609, CT3809 and CT1113 reported by elements of the 19th ROK Regiment at 312200. An estimated 30-40 enemy vicinity CT4211 were observed by patrol of 24th Division at 311230 and taken under friendly artillery fire resulting in 10 enemy casualties.

A 4 man enemy patrol was encountered by a patrol of 24th Division vicinity CT4108 at 310700. An unknown number of enemy approaching friendly positions vicinity CT3908 reported by element of the 19th RCT at 311820. An unknown number of enemy attacked elements of the 21st RCT and made a limited penetration to vicinity CT3906 at 312120. An unknown number of enemy launched 3 attacks against elements of the 19th RCT vicinity CT4306, CT4406 and CT4207 at 312200 with unknown results. An unknown number of enemy west, east and south of vicinity DS0360 reported by elements of the 23d ROK Regiment at 310955.

An estimated 1500 enemy moving east vicinity DS2981 reported by elements of the 9th ROK Division on 31 December. An estimated 1000 enemy vicinity DS3091 reported in contact with the 28th ROK Regiment on 31 December. A large concentration of CCF vicinity DS3897 reported by elements of the 9th ROK Division at 301935 (delayed report). An unknown number of enemy moving southeast vicinity DS2748 reported by 23d ROK Regiment at 311115. An estimated 200 enemy engaged elements of the 105th Engineer Battalion vicinity CS8955 on 31 December. An estimated 500 enemy vicinity CS8864 reported in contact with 5th ROK Regiment at 311100. An estimated 250 enemy vicinity CS9757 at 310400 and an unknown number of enemy vicinity DS2848 at 310700 reported by ROK police. An estimated 300 enemy defending a road block vicinity CS9263 reported by elements of 23d ROK Regiment at 311300. An estimated 100 enemy were engaged by elements of the 28th ROK Regiment vicinity DS3194 at 302200 (delayed report).

(9) Other Elements--Friendly air reported the following: Observed a possible enemy bivouac area vicinity CT4626 at 310545; attacked enemy supply dumps vicinity CT1508, CT2225 and DU1201 at 311230 and destroyed a POL dump vicinity BT9029 at 311003.

3. OTHER INTELLIGENCE FACTORS

a. Estimated Enemy Losses

(1) ROK 1st Division reported 1 PW during the period.

(2) ROK 6th Division reported 1 PW during the period.

(3) ROK 3d Division reported 248 enemy casualties and 5 PsW during period.

(4) US 2nd Division reported 15 enemy casualties and 15 PsW during period.

b. Weather--Sky Conditions and Ceilings: Clear until 1100 becoming scattered low clouds bases 4,500 feet by 1430 hours. Visibility: 5 miles at 0700 hours becoming

6-10 miles by 1200 hours. Precipitation: None. Maximum Temperature: 31° at 1500 hours. Minimum Temperature: 20° at 0700 hours. Further Outlook: Increasing cloudiness tomorrow.

c. Combat Efficiency - Excellent

d. Morale - Excellent

e. Status of Administrative Support - Negative

4. COUNTERINTELLIGENCE - Negative

5. ENEMY CAPABILITIES AT END OF PERIOD

a. Courses of Action

(1) To defend in present positions along 38° parallel.

(2) To attack south with the main effort astride the Yonchon - Uijongbu - Seoul corridors supported by an effort via Kaesong - Seoul; in conjunction with a secondary strong attack along the Hwachon - Chunchon - Kapyong axis with secondary efforts toward the south in the eastern mountain and coastal area.

(3) To attach south with the main effort astride the Hwachon - Chunchon - Wonju axis with the probable mission of effecting an encirclement of Seoul and/or drive toward Pusan; with containing attacks along the Yonchon - Uijongbu - Seoul axis.

(4) To conduct guerrilla activity with bypassed organized units throughout EUSAK zone and to attack rail, highway and communication facilities.

(5) To conduct limited air activity.

(6) To conduct limited airborne and amphibious activity.

(7) To be further reinforced by Chinese Communist and/or Soviet Forces.

b. Discussion of Capabilities - The buildup of enemy forces and materiel during the past several days along the northern and northwestern approaches to Seoul, as discussed previously, continues to point towards an imminent, all-out, main effort attack astride the Uijongbu - Seoul axis. Artillery in considerable numbers and the presence of bridging materials in the vicinity of the Imjin Gang are two of the more recent indications of the enemy's attack capability in this locale. Prisoner of war statements to the effect that the main offensive would commence the night of 31 December - 1 January and the reported enemy attacks which were developing into major proportions by the close of the period in both the US I and IX Corps sector further emphasizes the probability of an all-out drive for Seoul.

The success of enemy elements operating in the area south and southeast of Inje emphasizes the growing threat in the eastern sector. The expected immediate arrival of the NK III Corps and probable accompanying elements of the 3d Field Army from the Hungnam area will present the enemy with a suitable force for exploitation. The statements of prisoners, that the 12th NK Division is already in position to effectively sever the Wonju communications net, coupled with reports that the MSR has been cut in at least three places between Hongchon and Hoengsong, serves to point up the seriousness and apparent intent of enemy forces in this area. Despite the increasing numbers of enemy forces evident on the Army left front, the growing threat to our MSR and communications net on the east must not be overlooked.

c. Probability of Adoption - 5 a(2) in conjunction with 5 a(4), (5) and (7).

RIDGWAY
Lt. Gen.

OFFICIAL:

/s/ Tarkenton
G-2

2 Incls:
Incl #1 - Situation Map
Incl #2 - OB Highlights

Taegu	K-2
Pusan	K-9
Suwon	K-13
Kimpo	K-14
Seoul	K-16
Taegu	K-37

The physical characteristics, field facilities, and operating capabilities of each airfield (except Suwon) are given in considerable detail in Inclosure 1. Table I gives a condensed summary for all available airfields in Korea on 31 December.

Aircraft

6. On 31 December there were 363 fighter planes and bombers based in Korea. Table II lists these by type and base.

7. At the bases,planes were generally parked very near the runways. At Taegu, K-2, where there was the greatest number of planes, the most remote aircraft at any time was no farther than about 500 yards laterally from the runways. Virtually 100 percent of the aircraft at each base were grounded during the hours of darkness.

METHODS AND PHYSICAL EFFECTS OF ATOMIC ATTACK

Airburst

8. A blast overpressure of 4 psi suffices to inflict severe (crippling) damage upon aircraft; 2½ psi suffices for moderate damage.* Figure 4 , Appendix A of this report may be used to determine for an air-burst atomic bomb the ranges at which the above overpressures occur. For a 40 KT bomb-burst 3500 feet above the ground the range for 4 psi blast overpressure is seen to be 3250 yards, and for 2½ psi it is 4250 yards.

9. Figure 2 is a photograph of airfield K-2, Taegu, showing the range of severe aircraft damage for a 40 KT bomb-burst 3500 feet above the indicated ground zero. Such a burst would have annihilated all planes and facilities located at the airfield. In fact, the capabilities of a 40 KT weapon in such an attack are so great that a 2000-yard error in delivery could be made, and yet the blast would severely damage every plane and every structure on the field.

* See Appendix A, paragraph 97 for definitions of severe moderate and light damage to equipment.

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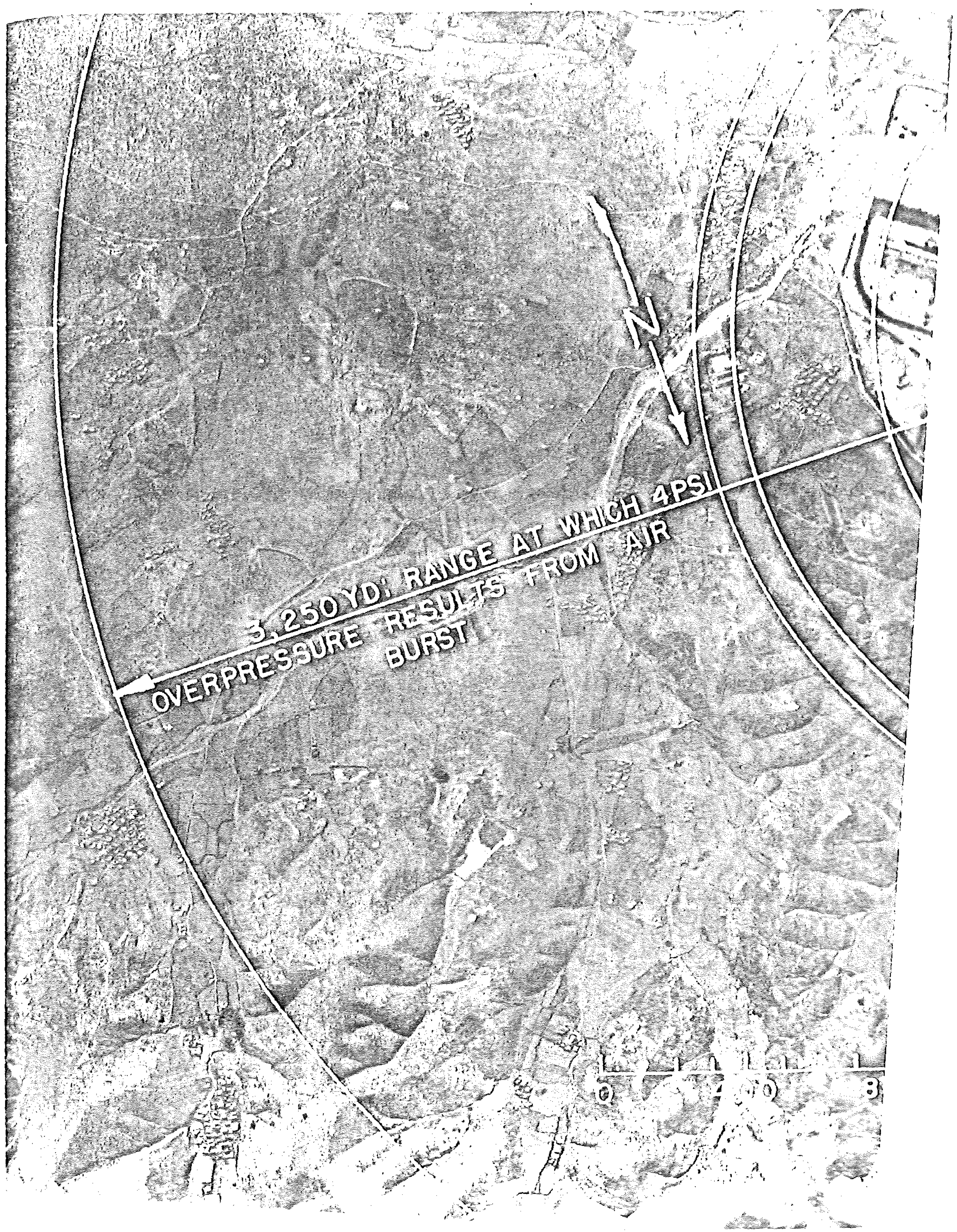

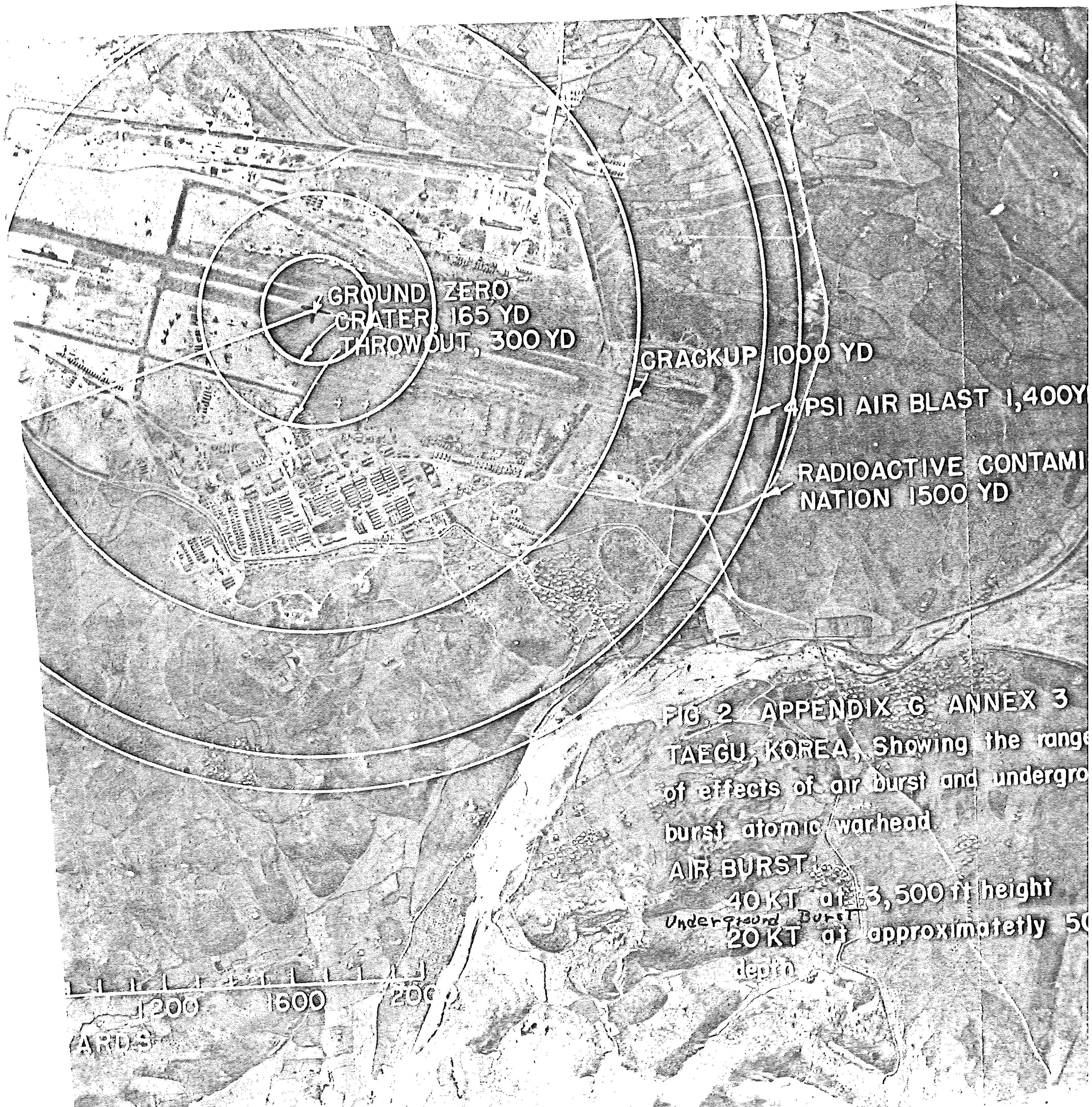

FIG 2 APPENDIX G ANNEX 3

TAEGU, KOREA, Showing the range of effects of air burst and undergro burst atomic warhead.

AIR BURST:

40 KT at 3,500 ft height

Underground Burst

20 KT at approximately 50 depth

APPENDIX G

TABLE I

KOREAN AIRFIELDS, 31 DECEMBER 1950

Name	Coordinates	Elev (Ft)	Runways	Operational Capabilities	Types
Taegu (K-2)	35-54 N 128-38 E	55	Two Magnetic bearings (1) N 54/00 W 5700' X 150' overrun of 750' S end & 800' N end (2) N 54/00 W 6500'X150' overrun 200' S end None N end	C-119 C-54 F-80	PSP Surface
(East) Pusan (K-9)	35-11 N 129-08 E	5	One Magnetic Bearing N 28/05 6005' X 150'	F-80 C-119 C-45	PSP Surface
Suwon (K-13)	37-15 N 127-02 E	60	One N-S 5118' X 150'	Heavy C-54 Type	Concrete
Kimpo (K-14)	37-33 N 126-54 E	58	Two Magnetic Bearings N 40/00 W (1) 6200' X 150' (2) 3710' X 150'	C-119 C-54 F-80 Emergency B-29	Asphalt Surface
Seoul (K-16)	37-31 N 126-55 E	35	Two Parallel NW-SE 3900' X 150' NW-SE 3500' X 150' 500' Overrun at each end	T-6 F-51 C-47	Sod PSP Surface
#2 Taegu (K-37)	35-50 N 128-41 E		One: EW 3600' X 140'	C-47	Graded Earth Surface

TABLE II

FIGHTER AND BOMBER CRAFT BASED IN KOREA
AS OF 31 DECEMBER 1950

Base	B-26	F-51	F-80	F-84	F-86	Totals
Taegu	--	1	81	71	27	180
Pusan	--	65	--	--	--	65
Suwon	--	63	--	--	--	63
Kimpo	1	6	46	--	--	53
Seoul	1	--	1	--	--	2
Totals	2	135	128	71	27	363

10. Secondary fires would probably result from an attack of this kind. Further losses would result from damage to equipment, instruments, and tools and from destruction of fuel, oil, and other supplies. Moreover, at least 95 percent of all base personnel would be casualties. The air base would be virtually wiped out. Only superficial damage would be done to the runways.

11. A bomb of smaller size, e.g., 20 KT, accurately placed, would do as great damage since its 4 psi blast-overpressure range would also fully encompass the airfield. Obviously, however, a lesser error in its placement would be required for a given degree of destruction.

12. The destructive effects of an air-burst atomic attack as indicated for airfield K-2 at Taegu would be equally applicable to all the Korean bases in use on 31 December 1950.

13. A night attack would probably be favored for an air-burst bomb of the larger size mentioned earlier. The important factors favoring such a night attack would be the large permissible bombing error and the presence of virtually all aircraft at their base fields during the hours of darkness.

Underground Burst

14. Figure 15 of Appendix A shows the damage radii for a shallow underground burst of a 20 KT atomic bomb. The effects depicted are expected to result from a burst at a depth of about 50 feet. Such depths of penetration would be generally possible at airfield sites in Korea, since these sites usually are located on valley floors covered with alluvium to depths at least as great as 50 or 60 feet. (Kimpo is an exception; there the maximum depth is only 20 feet.) Below the alluvium are hard rock formations which

would tend to reflect upward the ground-shock energy liberated by the penetrating bomb and would thus increase the ground surface area over which serious ground-shock effects would appear. Inclosure (2) gives further details of the subsurface structure at Pusan, Taegu, and Kimpo airfields.*

15. Figure 2 indicates conservative ranges of effects of a 20 KT underground burst centered on the Taegu field, K-2; no attempt is made to evaluate the effect of the substratum of hard rock which may be presumed to lie at or near the depth already indicated.

16. A penetrating bomb accurately placed at the center of the airfield, as shown, would destroy all aircraft and structures and would destroy the runways as well. A high percentage of all personnel at the airbase would be casualties. While a bombing error of 2000 yards can be tolerated when using a 40 KT air burst, considerably greater accuracy of delivery would be required for a 20 KT underground burst. In the latter case, however, an error of not more than 300 yards would still permit gross destruction of the field, the aircraft present, and the field structures.

Summary of Physical Effects

17. The 40 KT air-burst atomic bomb, if successfully delivered against the six Korean airfields actively employed by the 5th Air Force on 31 December 1950, would have resulted in complete destruction of the aircraft present and of the physical facilities as well. Heavy personnel casualties would have resulted. Heavy damage would have been possible even with bombing errors as large as 2,000 yards.

18. The 20 KT underground burst would have been equally effective in all these respects but would have required considerably greater bombing accuracy. Within bombing errors of about 300 yards, the runways would have suffered gross damage by cratering and ground-cracking.

19. Assuming the above accuracies of delivery, a table of aircraft destroyed or seriously damaged at each of the airfields would be the table of aircraft present at the time of attack. For the night of 31 December, therefore, Table II gives the aircraft losses for atomic attacks on all the airfields in use.

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* Geological Surveys Branch, Intelligence Division, Engineer Section, Corps of Engineers, GHQ, FEC, File NO. CE 461, 26 February 1951.

MILITARY CONSIDERATIONS AND EFFECTS

Evaluation of Aircraft

20. It is possible to establish at least a rough measure of the military value of the Korean-based facilities of the 5th Air Force on the date chosen for study, 31 December 1950. To do this they will be compared with facilities located elsewhere and available to the UN Forces. Table III makes such a comparison for fighter craft.

TABLE III

FIGHTER AIRCRAFT AVAILABLE TO FEC

FEAF Fighter Planes (F51, F80, F82, F84, F86)	Number
Korea based	361[a]
Japan based	189[b]
Okinawa	204
Total FEAF[c]	754[d]
Navy Fighter planes (F4U, F9F, AD, Sea Furies, Fireflys)	295[e]
Marine Fighter Planes (F4U, F7F, F9F)	134[e]
Total FEC	1183

a. Table II of this annex
b. FEAF, Combat Readiness Report Daily, AF-SC/C6, 6 Feb 51
c. Does not include the limited number of ROK aircraft
d. FEAF, 110-B, Daily report of Aircraft Gains and Losses, 1 Jan 51
e. Quoted by FEAF, Operations Section.

21. While the sources quoted are not all dated 31 December 1950, the figures, nevertheless, make a significant comparison possible. If the planes based at Okinawa, Guam, and the Philippines are excluded from the comparison, Table IV shows that the Korean-based planes which provided continuous and unbroken close support of combat operations represented about one third of the total number readily available.

Evaluation of Airfields

22. A study of Table I shows that the only Korean airfields available for handling the F-80 series of planes

were in use on 31 December. Half of those capable of handling the F-51 were in use: those not in use were generally in poor condition. Fifteen of the 18 airfields available could have handled cargo aircraft. Destruction of the six airfields in use, and their runways, by enemy attack with an underground burst, would have destroyed a major portion of the facilities established for the handling of fighter craft in Korea, but would have left an ample number of fields capable of handling air cargo. The fields destroyed would probably not have been worth restoring as military bases. Furthermore, reconstruction probably would not have been feasible because of gross cratering, ground-cracking and radioactive contamination.

TABLE IV

FIGHTER AIRCRAFT AVAILABLE FOR CONTINUOUS SUPPORT

Base or Service	Number of Fighters	Percent
Korea	361	36.8
Japan	189	19.3
Navy	295	30.2
Marines	134	13.7
Totals	979	100.0

23. Destruction of field facilities and aircraft with an air-burst would not do serious damage to runways. Almost immediate resumption of limited staging operations would have been possible following such an attack upon any or all of the Korean airfields. Full-scale operations could have been achieved and resumed within a few weeks.

24. This swift expansion of operations would have been possible partly because of the limited nature of airfield operations in Korea. Repairs at the Korean fields involved at the most no more than aircraft maintenance. Engine repairs were made at bases in Japan or even in the US.

25. The UN Forces and the 5th Air Force were by no means entirely dependent upon the Korean air bases. Operating bases existed in Japan and were in daily use. In addition, 5 aircraft carriers were in the theater, and three were in position to carry on daily combat operations with their aircraft. The Japan bases which were equipped for fighter action are listed below, with their approximate distances from the 8th Army front line and from the Yalu River on 31 December 1950. Taegu, Korea, is included for comparison.

TABLE V

FIGHTER BASES IN JAPAN
Taegu, Korea, added for comparison

Base	Distance from Front Line (Nautical miles)	Distance from Yalu River (nau. miles)
Johnson	740	915
Itami	500	675
Tsuiki	330	505
Itazuke	310	485
Taegu, Korea	160	335

FEC fighter bases in J. 1951.

The distances given in Table V are not along great circles but along the route which crosses the Korean Straits.

26. In order to estimate the degree of support which aircraft flying from these bases could have given UN Forces in Korea, it is necessary to consider the ranges of aircraft flying on various types of missions. Table VI gives ranges for fighter aircraft. The data were taken from AMC, USAF Official Staff Characteristics Book.

27. Study of the table indicates that penetration even to the Yalu River would not have been denied to any of the aircraft listed except possibly the F-80C, by reasons of a loss of bases in Korea and a dependence on bases in Japan. Distances from Tsuiki and Itazuki to the front lines would have been double the distances required in flight from Taegu. Distances to more remote targets would have been increased by a lesser factor. Had it been necessary to bring Japan fighter bases other than the two already mentioned into use, greater in-flight distances would have been imposed on operations. It may be assumed, from the foregoing, that a forced shift from bases in Korea to bases in Japan would have roughly doubled the number of aircraft required to maintain a given level of aerial operations over Korea by the 5th Air Force.

Daily Scale of Operations

28. The scale of operations maintained by the 5th Air Force during the period of study may be seen in Table VII.

29. The sharp increase in activity following the general assault by the enemy along Line Baker on the nigh of 31 December 1950, is seen in Table VII. The 8th Army' successful withdrawal may have been largely dependent upo

TABLE VI

AIRCRAFT CHARACTERISTICS

Combat Radius Nautical Mi	Cruising Altitude	Type Craft	Ordnance and External Fuel Containers	Combat Capability
380	25,000	F-51	0.50 Cal Ammo only	20 min at 25,000'
770	25,000	F-51	2 110-gal tanks	20 min at 25,000'
800	10,000	F-51	6 5" HVAR Rockets with 2 110-gal tanks	5 min at 10,000'
125	36,000	F-80C	max Rockets or 2000-lb bombs	Attack 5 min at Sea Level
185	40,000	F-80C	Ammo only	Intercept 20 min at 40,000'
474	36,000	F-80C	2 165-gal tanks	Basic * 20 min at 36,000'
349	15,000	F-82	25 5" HVAR Rockets	5 min at Sea Level
2174	25,000	F-82	2 310-gal tanks	Recon
218	40,000	F-84E	Ammo only	Intercept 20 min at 35,000'
388	20,000	F-84E	8 5" HVAR Rockets	Attack 5 min at Sea Level
678	35/40,000	F-84E	2 230-gal tanks	Basic * 20 min at 35,000'
102	10,000	F-86A	max Rockets	Rocket ftr 5 min at Sea Level
168	35,000	F-86A	Ammo only	Intercept 20 min at 35,000'
490	35,000	F-86A	2 206-tanks	Basic * 20 min at 35,000'

* "Basic" means the basic type of mission for which craft was originally designed.

the degree of aerial support which this sharp increase suggests.

TABLE VII

FIFTH AIR FORCE SORTIES*

Kind of Sortie	31 Dec	1 Jan
Close support	27	229
Armed reconnaissance	43	107
Photo reconnaissance	12	12
Night intruder (B-26)	34	36
Counter air	2	54
Light bomber (B-26)	21	23
Tactical coordination	26	58
Total	165	519
Aborts	13	14
Effectives	152	505

* FEAF, Director of Intelligence, Daily Mission Summary.

CONCLUSIONS

30. From the foregoing discussion, it may be concluded that:

a. The great effective damage radius of the 40 KT air burst atomic bomb when employed against airfields would have made it a valuable weapon to the enemy on the night of 31 December 1950, for employment against UN airfields in South Korea. Its effective radius would have given the enemy his maximum opportunity of making a successful attack against a strongly defended airbase.

b. On the given date the enemy would have found his immediate advantage in destroying as many as possible of the UN Korean-based aircraft and ground facilities. His immediate advantage would not have been greatly enhance(by an accompanying destruction of the runways of the six fields in use, plus the usable runways of the remaining fields, since loss of the aircraft and ground facilities alone would have temporarily halted operations from Korean bases.

c. Four hundred and sixteen of the 422 aircraft based in Korea on 31 December 1950 and all the ground facilities of five bases could have been destroyed by five air-burst atomic bombs successfully delivered. In additio the six planes and ground facilities at K-37 could have been destroyed by an air-burst atomic bomb employed agains the 8th Army and 5th Air Force Headquarters at Taegu (See Annex II of this appendix).

d. Destruction of all or a major portion of these aircraft and facilities on the night of 31 December undoubtedly would have prevented the large increase in air support which the 8th Army required on the following day in its defense against the general enemy offensive.

e. Denial of this aerial support might have been exploited by the enemy by coordinating it with his front-line assault in such a way as to inflict major casualties and a serious reversal upon the 8th Army. Such advantage could have been gained by the enemy only by immediate exploitation of an attack against the air bases.

f. Essential recovery of the tactical advantage lost through the enemy's destruction of the Korean based planes, ground facilities, and personnel could have been realized as quickly as the remaining facilities and non-Korean bases could have been organized to pick up and carry the entire operations load. According to Table IV about two thirds of the fighter aircraft available for continuous unbroken support would have remained after a destruction of those based in Korea.

g. During the initial period of recovery, following an air-burst atomic assault, when adequate Korean bases would not yet have been reestablished, the 5th Air Force and cooperating services would have had to double their effort roughly, to achieve and maintain the required scale of operations from bases outside Korea.

h. At least fifteen successfully delivered underground-burst bombs would have been required to destroy all usable runways of the South Korean fields on 31 December. Such weapons largely would have destroyed planes, ground facilities, and personnel as well. Successful use of underground bursts, however, would have been a much greater military delivery problem than successful use of air-burst weapons.

i. Destruction of all or any significant part of the runways would have delayed reestablishment of Korean-based air operations with denial of attendant advantages of such operations.

ANNEX 3

INCLOSURE 1

KOREAN AIRFIELDS

MAT-INST-E
28 November 1950

NAME	COORDINATES	ELEVATION	RUNWAYS	TYPE
Taegu K-2	35-54 N 128-38 E	55'	Two: Magnetic bearing N 54/00 W; N 54/00 W One 5700' X 150' overrun of 750' S end and 800' N end One 6500' X 150' overrun 200' S end none on N end	PSP Surface

Type of Construction: PSP over river run gravel and sand. After PSP was laid failures developed where double planking was laid over mud boils. The subgrade developed an extreme "wash board" effect and the top layer of plank slipped over the surface of the under layer of plank, causing buckling in the top plank. To correct, buckled plank was cut out and repaired, and to stop the creeping and establish a level grade in order to improve rough PSP conditions on 6500' R/W, cold mix asphalt containing graded gravel is worked under mat and, if a study now underway indicates feasibility, an asphalt top will be run over PSP.

Taxiways: Parallel taxiway constructed on the North side of the field extending 3300 feet from the SE end of the field. Approximately 1300' of taxiway on South side of field, extending out from strip at point 1400' from SE end of field.

Parking Area: 7,755,000 sq. ft. of asphalt stabilized parking areas in two sections; on North side from NW end of strip, extending approximately half length of strip; on south side of strip, extending half length.

Facilities: POL area is located on South side of field, adjacent to RR siding capable of handling 15 tank cars. System consists of four 1000-barrel tanks for J-1 storage and two 1000-barrel tanks for aviation-gas storage with necessary pumps and water separators and three truck fill-stands.

2 concrete aprons, 340' X 160' each;
Hangars: 2-105' X 150', 1-120' X 125';
320' X 100' concrete aprons at each hangar.

Existing Buildings: 60 Barracks 20 X 90' 6 1/2"; 1 Dispensary 20 X 100; 3 messes, 3 units 20' X 100' per unit; 5 Latrines 16 X 32'; 5 operation buildings, 3-20 X 20', 2-35 X 50'.

Routes of Communication: Spur from the Taegu-Pohang line enter airfield on south side of field. One siding at POL area and two lines into ammo storage area. Field is located 5 miles east of City of Taegu, rail and highway center for South central Korea.

Operational Capabilities: C-119, C-54 and F-80.

Obstructions: No obstructions in glide and approach zones.

Possible Expansion: None.

Climatic Conditions: Prevailing Winds: Jan thru Dec--West. AV. Vel. 5.0 MPH. Annual rainfall averages 37.5 inches, with maximum precipitation occuring during period June through September (25 in). Winter months are dry, with an average of 16.8 days per year during which snow occurs. Average temperature ranges from 30 degrees in January to 80 degrees in August with extreme lows during winter months of approximately 16 degrees.

Remarks: Data compiled from existing intelligence files, ground reconnaissance, construction reports, topo map of area completed.

NAME	COORDINATES	ELEVATION	RUNWAY	TYPE
Pusan (East) K-9	35-11 N 129-08 E	5'	One: Magnetic bearing N 28/05 W. Area 6005'X 150'	PSP Surface

Type of Construction: PSP surface over stabilized base, treated with asphalt dust palliative; condition good.

Taxiways: Taxiways, 50' wide, parallel to strip on E and W. PSP surface over stabilized base. 200' X 300' warmup aprons at each end of runway.

Parking Areas: 17 hardstands 85' X 45', 8 hardstands 60' X 80'. PSP surface over asphalt stabilized base. 480,000 sq ft of asphalt stabilized parking area at SW end of strip.

Facilities: POL 2 1000-barrel tanks, 4" pipeline from Pusan. One truck fill-stand and two car rail unloading-stands. Water supply is from reservoir on hills east of field with distribution system (pipeline) to field installation. Electrical distribution system serves base. 1400' apron on east side of field, 100' wide; 860' concrete, balance PSP to cover asphalt base.

Existing Buildings: 34 - 20' X 99' 6 1/2"
7 - 20' X 100'
5 - 20' X 50'
2 - 35' X 115'
1 - 25' X 50' - Two story
1 - 30' X 50'
1 - 25' X 50'
1 - 20' X 35'
1 - 20' X 50'

Construction not completed at this date.

Routes of Communication: Approximately 9 miles from port area of city of Pusan, via two-lane gravel road, Branch of Pusan-Taegu RR adjacent to field with two sidings 500 yards from strip.

Operation Capabilities: F-80, C-119, and C-45.

Obstructions: Mountains parallel to and on both sides of field, rising from field boundaries to approximately 2000' elevation. Approaching zones are clear.

Possible Expansion: None.

Climatic Conditions: General conditions same as K-1.

Remarks: Data compiled from existing intelligence file, and ground reconnaissance July 1950. Construction still in progress at this base.

MAT-INST-E
28 November 1950

NAME	COORDINATES	ELEVATION	RUNWAY	TYPE
Chinhae K-10	35-8 N 128-41 E	10'	One: Magnetic bearing N 10/00 W, 3200'X 175', 1500 ft extension under cons. on N end of strip, by ROKAF	Sod Surface

Type of Construction: Sod surface. Good drainage. Base is 6" - 9" sand-clay over 6" rock fill. Sub-base is fine to medium sand. Surface condition good.

Taxiways: None.

Parking Areas: Sod area on East side strip approximately 2000'X 250'.

Facilities: Open storage of aviation gas in area east of shops. Ammo and bomb storage in underground vaults constructed by Japanese. Water supply from Chinhae Municipal plant. Sewage system installed but not in operation at this date. Electric power, (50 cycles), obtained from commercial sources.

1 steel hanger 250' X 190', minus roofing and siding steel;
1 steel hanger, 175' X 175';
1 hanger, 190' X 100';
1 shop, 100' X 125';
1 shop, 50' X 150';
3 shops, 50' X 100'.

Existing Buildings:

18 - 100' quonsets;
15 - 50' quonsets;
4 - 20' X 100', Supply and Administration bldgs;
1 - H-shaped mess 25' X 125';
1 - Headquarters, Japanese built 50' X 200', with 30' X 75' wing;
1- 'L' bldg. 20' X 75' X 75';
1 - 2-story Japanese building 100' X 175'.

Routes of Communication: Located on Kanganwan Bay, 2 miles E of Chinhae. Nearest Railroad located at Mason 8.7 miles NW. Harbor at Chinhae will accomodate LST at dockside.

APPENDIX G

Operation Capabilities: Limited C-47, all weather operations.

Obstructions: Mountains 2500' high 7 miles NW of strip.

Possible Expansion: Possible to extend to NW to total of 6000 feet.

Climatic Conditions: Conditions generally same as K-1.

General Remarks: Data compiled from existing intelligence files, and ground reconnaissance August 1950.

MAT-INST-E
28 November 1950

NAME	COORDINATES	ELEVATION	RUNWAY	TYPE
Kimpo K-14	37 deg 33' N 126 deg 54' E	58'	Two: Magnetic bearing N 40/00W; N 50/00 E. 6200' X 150' and 3710' X 150'	Asphalt Surface

Type of Construction: Japanese built with additions by Americans; Asphalt-surfaced with average depth of 4"; 17" sub-base of rock on naturally compacted sub-grade of decomposed granite. Drainage of runways fair.

Taxiways: An extensive taxiway system connects the ends of the runways and the apron. Approximately half of the taxi net has been surfaced with PSP, the balance is asphalt-surfaced. Bomb damage repaired with PSP and asphalt.

Parking Areas: Concrete.

Facilities: POL: 5-1000 and 2-10,000 bbl tanks with de-drumming device, located SW of main runway. 4" pipeline for transporting JP-1-fuel from port of Inchon, and additional 6" line is under construction. Water, sewage are presently being rehabilitated. Rehabilitation of maintenance facilities in progress November 1950.

Existing Buildings: Extensive bomb damage. Rehabilitation of housing area began October 1950.

Routes of Communication: Ten miles W of Seoul, 1-1/2 miles S of Han River. Primary two-lane asphalt road connects base with city Yongdungpo, Inchon road. Field is 17 miles from port of Inchon (secondary harbor).

Operational Capabilities: All weather operations C-119, C-54 and F-80. Emergency operations B-29.

Obstructions: Hill to South of main runway just within critical glide angle for F-80 operation. 1295' hill 10 miles WNW from AF.

Possible Expansion: Limited by developed areas.

Climatic Conditions: Annual mean precipitation 46.7 inches with heaviest fall during months of July and August. Snow fall averages 32.5 days annually. Annual mean temperature 52 degrees F with mean high 78 degrees F in August to mean low of 28 degrees F in December. Annual mean wind-speed of 4.1 MPH. Prevailing Winds are: WNW from Nov through Feb; SW from Mar through July; ENE from Aug through Sept.

General Remarks: Data compiled from existing intelligence reports, and ground reconnaissance October 1950.

MAT-INST-E
10 December 1950

NAME	COORDINATES	ELEVATION	RUNWAY	TYPE
Seoul K-16	37-31 N 126-55 E	35'	Two (2) Parallel NW-SE 3900' X 150' NW-SE 3500' X 150' 500' overrun on both ends.	Sod PSP

<u>Type of Construction</u>: Sod-surfaced field with two old concrete runways, 1775' X 50' and 1300' X 50', within the area. The entire area is well sodded and standing up well under moderately heavy T-8, P-51 and C-47 traffic.

<u>Taxiways</u>: Sod, PSP later.

<u>Warmup Pads</u>: 100' X 300' each end of runway.

<u>Parking Area</u>: Aircraft parking on sodded areas of field.

<u>Facilities</u>: No POL facilities. Three small hangars, all damaged by bombing.

<u>Routes of Communication</u>: Located across the Han River from Seoul. Approximately 27 miles NE of port city Inchon (secondary harbor).

<u>Existing Buildings</u>: None.

<u>Operational Capabilities</u>: T-6, F-51, C-47.

<u>Obstructions</u>: None.

<u>Possible Expansion</u>: 2500' on SE end of runway.

<u>Climatic Conditions</u>: Conditions similar to Kimpo (D-14)

<u>General Remarks</u>: Data compiled from existing intelligence summaries and ground reconnaissance October 1950, Plot plan, dated 1 Dec 1950.

MAT-INST-E
9 Jan 1951

NAME	COORDINATES	RUNWAYS	TYPE
Taegu #2 (Taikyu #2)	35-50 N 128-41 E	One; E/W; 3600' X 140'	Graded Earth

Type of Construction: Graded earth. West end of runway being extended 420 feet.

Taxiways: None.

Parking Area: 1250' X 700', approximately 400' S of W end of R/W.

Facilities: None

Route of Communication: Approximately 1.25 miles S of Taegu.

Existing Buildings: Approximately 206 buildings in area S of runway. 21 quonset-type buildings, approximately 98' X 14'; two supply buildings 105' X 20'; one supply building 105' X 28'; one administration building; three mess halls. The remaining buildings are quarters and supply buildings.

Operational Capabilities: C-47

Obstructions: Unknown

Possible Expansion: Runway to 5000'.

Source of Information,
5th Air Force
First Construction Command.

ANNEX 3

INCLOSURE 2

21 February 1951

MEMORANDUM REPORT:

SUBJECT: Subsurface conditions at Pusan, Taegu, and Kimpo airfields, Korea.

This report on the subsurface conditions at Pusan, Taegu, and Kimpo airfields in Korea was prepared at the request of Operations Research Office, G-3 Operations.

1. Pusan Airfield

a. The runway has a pierced-steel plank surface, over a stabilized base treated with asphalt dust palliative.

b. The field is built upon alluvial material of unknown thickness, but estimated to be 25 to 150 feet thick. The alluvial material consists of unconsolidated clay, sand, and gravel.

c. Underlying the alluvium is a formation composed of layers of fairly hard trap rock interbedded between layers of softer tuff (rock composed of volcanic ash and some coarser and harder particles cemented together). It is not known whether the trap rock or the tuff makes up the top of the formation directly under the alluvium. The harder trap rock may be directly under the alluvium in all or part of the airfield area, or the tuff may be. If the tuff is at the top, it is likely that within a depth of 50 feet below the alluvium the harder trap rock would be encountered. If the trap rock is at the top, it probably has a thickness of 5 to 50 feet with tuff underneath. The upper few feet of it might be somewhat decomposed.

d. The tuff is an indurated rock and is somewhat stronger and harder than alluvium, but not as strong or hard as undecomposed trap rock. The decomposed trap rock is poorly consolidated and clayey and thus more like alluvium.

2. Taegu Airfield

a. The runway surface consists of two layers of pierced steel planking which has 2 to 3 inches of cold mix asphalt with graded pea gravel aggregate tamped between the layers. The lower layer of planking rests on a base of sand and gravel which lies over 6 or 7 inches of shale. A clay loam soil underlies the shale.

b. The clay loam soil grades into and is derived from alluvial material which probably consists mostly of clay and sandy clay, but contains some sand and gravel. The thickness of the alluvium is unknown but it is estimated to be from 25 to 150 feet. This material is unconsolidated, but probably firmly compacted near the base.

c. The alluvial material is underlain by shale and mudstone with a few interbedded layers of sandstone. This rock is made up of clay particles, sand grains, or sand grains and clay particles which have been cemented together. Thus, it is fine-grained and indurated, but not very hard rock. This formation is probably at least 1000 feet thick beneath the airfield.

3. Kimpo Airfield

a. The runway is surfaced with asphalt averaging 4 inches in thickness, over a Telford base (large blocks of rock, hand laid) 12 to 17 inches thick which rests on a naturally compacted sub-grade of decomposed granite.

b. The field area is underlain by granite, the upper part of which is decomposed to a sandy clay deposit having properties similar to compacted unconsolidated alluvium. The decomposition probably extends to a maximum depth of 20 feet and is considerably thinner than that over much of the area. The contact between the decomposed rock and hard undecomposed rock is probably somewhat gradational. However, over parts of the field small granite hills were removed during construction and fresh granite may be at or near the surface. The granite probably extends to great depth.

c. The northwestern end of the field may be underlain by alluvium probably composed mostly of clay and sand.

4. Sources of Information:

a. Pusan

Intelligence Summary, Korean Airfields, compiled by First Construction Command, 5th Air Force, 15 Nov 1950 (SECRET) Japanese geologic maps, scale 1:1,000,000; low reliability.

b. Taegu

Air field Reconnaissance Report, Taegu, 69th Topo. Co. Survey Platoon, 29 January, 1946 (Unclassified) Intelligence Summary, Korean Airfields, compiled by First Construction Command, 5th Air Force, 15 Nov 1950 (SECRET) Fairly reliable Japanese geologic maps, scale 1:50,000. Air photos: Scale 1:15,000.

c. Kimpo

Intelligence Summary, Korean Airfields, compiled by First Construction Command, 5th Air Force, 15 Nov 1950 (SECRET) Oral discussion with a U. S. Geological Survey geologist who had studied the subsurface conditions of the field in 1945. Air photos: Scale 1:7,500.

Helen L. Foster
Geologist, U. S. G. S.
Intelligence Division
Engineer Section, GHQ, FEC

ANNEX 4

AN IMPORTANT LOGISTICAL TARGET

The Port of Pusan, October 1950

INTRODUCTION

1. The vulnerability to enemy action which has characterized the Port of Pusan throughout the Korean campaign is easily demonstrated. On the one hand, it represented an important facility in the logistics of the Fifth Air Force, the Eighth Army, and associated UN Forces in Korea; on the other hand, relatively little effort was spent to create a defense system capable of warding off a determined enemy air attack against it. Moreover, weapons far less expensive and generally more plentiful than the atomic bomb could have done serious harm, e.g., sea mines, or HE bombs. These facts are well known. The brief statement of facts made here is meant in no way as a criticism of the military planning and tactics devised for the use of the port. It is made solely as a means of defining the problem of vulnerability to atomic attack with which this study deals.

2. The present study attempts to illustrate graphically in what ways the Port was vulnerable to atomic bombing. The study gives a concrete conception of the physical, military, and other effects that a bomb or bombs might produce if used against Pusan or against any port of similar characteristics and significance in wartime. The study is not concerned with the means the enemy may or may not have had to make an atomic attack during the period to which the study is directed.

PHYSICAL DESCRIPTION OF TARGET SYSTEM

3. Pusan presented a multiple target system with principal components as follows:

a. The logistical base, including operating personnel.

b. The port facilities, including operating personnel.

c. Ships in the port and its approaches, their crews, their cargoes, and military personnel, equipment, and supplies aboard.

4. Components a and c have varied from time to time, particularly c. Inclosure 1 describes the components of the Pusan target, as they existed on 16 October 1950. On this date component c was of particular importance since there was then a large naval fleet at anchor in the north harbor and its entrance channel, carrying a large portion of the X Corps. Inclosure 2 gives detailed information concerning the weather at Pusan on the given date.

5. Important details given in Inclosure 1 for October 1950 are summarized or listed in the following:

Part I-- physical facilities of the port and of the logistics base are given in Figure 1, Inclosure 1 (see envelope inside back cover).

Part II--ships present in the port and its approaches on 16 October totaled 112; they were assumed in this study to have been uniformly dispersed and at anchor.

Part III--X Corps personnel totalling in excess of 20,000 were present, with all of their field equipment, and several days' supply of food and other consumables on board 48 of the ships at anchor. According to GHQ, UNC, Operations Order No. 2, 2 October 1950, the aggregate authorized strength of the X Corps with ROK troops attached was 75,900. Hence, the X Corps forces involved in this study represented well over 25 percent of the entire X Corps.

Part IV--Personnel at Pusan assigned mainly to the port and to the 2nd Logistical Command totaled about 12,500. The billet locations are given in Figure 1, Inclosure 1.

Part V--the logistical supply of the Eighth Army was located in dumps, farms, and warehouses around the harbor and in North Pusan. The locations of the supply and storage facilities are given in Figure 1, Inclosure 1.

6. Inclosure 2 shows the weather at Pusan on 16 October 1950.

The existing weather conditions would have limited somewhat the effects of both air burst and shallow water-burst weapons. In particular, the thermal radiation incident on the target area from an air burst would have been significantly reduced by the hazy atmosphere; radioactive fall-out from a shallow underwater burst in the harbor and its approaches would have been displaced somewhat off the target areas by the generally prevailing southwest winds.

METHODS AND PHYSICAL EFFECTS OF ATOMIC ATTACK

The Logistical Base

7. The logistical supply installations would have required five 40 KT bombs burst at 2000-2500 feet height above ground to insure the destruction of not only the warehouses and other structures but also most of the supplies contained therein. The desired ground zeros are indicated on Figure 1, Inclosure 1. It is assumed that a CPE of 500 yards could be achieved in the bombing.

8. Through clandestine agents and through his undoubted possession of port maps and detailed knowledge of established facilities, the enemy could probably have designated most of the required ground zeros with accuracy. Nevertheless, accurate and dependable placement of all five weapons would have been a difficult military task because of the dense bombing pattern required in a multiple bomb attack.*

The Port Facilities

9. A multiple atomic-bomb attack directed at the logistical base would have done serious damage to all of the port facilities and would have sunk or otherwise damaged several ships in the north inner harbor. However, the principal and most important facilities of the port could have been destroyed by a single 40 KT bomb burst at 2000-2500 feet between Piers 2 and 3 as shown on Figure 1, Inclosure 1. Such a burst would have destroyed or very severely damaged the 4 piers, the railway terminal, and the CP of the 2nd Logistical Command. Moreover, many of the gasoline tanks on the tank farm at Area J, Figure 1, Inclosure 1, would have been ruptured by the blast, and a very serious fire undoubtedly would have occurred over the harbor area which ultimately would have enveloped at least that portion of Pusan bordering the north inner harbor on the west side. Approximately 18 ships and barges would have been sunk or immobilized in the harbor, including USS ELDORADO and USS JACONA, thus limiting the further use of even those harbor facilities most remote from and least damaged by the blast.

10. A bombing technique capable of a CPE no greater than 500 yards would probably have sufficed for destruction of the major port facilities by a single bomb. This would have rendered the port useless as a major logistic facility until time-consuming and costly restoration and clearance had been accomplished.

* See Appendix B, par 46-52, and Appendix B, Annex 4.

The Ships in the Harbor and Its Approaches

11. The ships, their cargos, and their crews and passengers probably could have been attacked best by underwater bursts. Two 40 KT bombs sunk and detonated at the places indicated in Figure 1, Inclosure 1, would have sunk fewer ships than the same bombs air-burst at 3000 feet, yet they would probably have produced higher personnel casualties by radioactive contamination. Roughly estimated damage to ships is indicated in Table I.

TABLE I

DAMAGE TO SHIPS BY TWO 40 KT UNDERWATER BURSTS

Damage	Number of Ships	Percentage of Total Number Present
Ships sunk	22	20
Ships immobilized	27	24
Ships suffering serious loss of efficiency	19	17
Totals	68	61

12. The three physical agencies which would have produced the greatest number of casualties among shipborne personnel would probably have been nuclear radiation, mauling received from the accelerated motions of the ships, and drowning. The motions would have arisen from the shock wave in water, the blast wave in air, and the wave action on the surface of the water. The nuclear radiation and contamination effects would have been diminished somewhat by the prevailing southwest wind blowing across the harbor approach-channel. Nevertheless, the lethal range of radiation crosswind along the direction of the channel would have been large. It is estimated that a radiation dose of 1000 roentgens or more would have been received as far as 2700 yards from the point of detonation, along the water surface in the direction of the channel.* Such ranges measured from the two assumed burst points would have covered practically the entire anchorage. Considerable radiation shielding would have been afforded personnel by the hulls and decks of the ships. Nevertheless, a very rough estimate would indicate a personnel casualty-rate, for the anchorage as a whole, of about 75 percent, resulting from the multiple causes.

13. Hence, the entire 7th Infantry Division and many of its attached units would have been destroyed as organized

* See, Effects of Atomic Weapons, p 276 et seq.

combat forces. More than half of the ships would have been sunk or severely damaged. Some of the remaining ships would have been temporarily immobilized by high casualties among their crews.

14. Wave action on the water surface of the harbor would have produced considerable damage to harbor facilities rimming the harbor. Ships sunk in the harbor and in the approaches probably would have blocked the port seriously enough to have imposed an extended clearance problem of large magnitude.

15. In order to produce the heavy damage just indicated, a CPE of about 500 yards would have been required for the bomb delivery in the attack on the ship target.

Summary of Effects; Comparison of Methods of Attack

16. An attempt is made in this section of the enclosure to evaluate in numerical terms all of the effects mentioned and described in the preceding sections. The evaluation is undoubtedly crude since the knowledge of weapon effects of interest here is imperfect and incomplete. Nevertheless, at least a rough comparison of the three methods of attack described should be possible. The estimated numerical results already quoted are included in the following tables. By "principal port facilities," appearing in Table II is meant:

a. The four piers, adjacent wharves, and associated facilities.

b. Port headquarters, 2nd Logistical Command Headquarters, and Naval Headquarters.

c. Railway terminal.

TABLE II

PHYSICAL DAMAGE, FROM THREE METHODS OF ATTACK
PERCENTAGE OF WHOLE TARGET COMPONENT SUNK, DESTROYED, OR SEVERELY DAMAGED

Target Component	Attack on Base	Attack on Port	Attack on Ships
	Percent	Percent	Percent
Base and supplies	95	35	10
Principal port facilities	85	100	30
Other port facilities	95	50	40
Ships	22	15	61

TABLE III

PERSONNEL CASUALTIES FOR THREE METHODS OF ATTACK
PERCENTAGE OF CASUALTIES OF WHOLE TARGET COMPONENT

Target Component	Attack on Base	Attack on Port	Attack on Ships
	Percent	Percent	Percent
Base personnel	95	40	10
Port personnel	95	50	30
Ships' crews and personnel of X Corps Units	25	18	75

17. A few important comparisons between methods of attack stand out in the tables but only within the validity of the figures given. The attack on the base is more destructive of the port as a whole, and its personnel, than the attack on the port itself. This is to be expected since the base facilities hug the port closely and since an attack on the base employs five bombs compared to one for the attack on the port. Nevertheless, the latter attack does what it was designed to do; it wipes out the principal port facilities. The base and port attacks jam the north inner harbor with a significant number of sunken or disabled vessels. However, the ship attack obviously does maximal damage to the entire fleet while doing minimal damage to the base and port facilities.

MILITARY, ECONOMIC, AND POLITICAL EFFECTS OF ATOMIC ATTACK

The Logistical Base

18. The Table of Logistical Supply, given in Inclosure 1, Part V, demonstrates the importance of the Pusan base to the UN Forces and their close dependence upon it. POL was in especially short supply at forward bases on 16 October 1950. Destruction of the base and its accumulated supplies, together with port damage which would be achieved by the described atomic attack on the base, obviously would have checked the forward movement of the UN Forces very quickly and kept them checked until other means of supply had been established. However, the military problem in delivery and placement of five bombs over so small a target area, with the requisite accuracy, would probably have made such an attack less attractive than either of the other two already described.

The Port Facilities

19. The importance of the Port of Pusan to the UN

Forces is demonstrated by the data given in Inclosure 3. The preponderate part of total tonnage was being moved to Korea by water, and, furthermore, there was no possibility of expanding movement by air in amounts that could significantly replace movement through the principal sea port. Pusan was handling 81 percent of the movement by water and Inchon handled the remainder. Loss of the Pusan port, therefore, would have meant an immediate reduction by about 80 percent of the daily supplies reaching Korea.

20. This reduction possibly could have been replaced in time to prevent disaster by bringing other ports and possibly even beaches into use. Inchon also could have been more fully exploited. Inclosure 3 indicates these possibilities. In spite of these however, the loss of the Port of Pusan and its operating personnel through a single-bomb attack would have imposed a serious handicap upon the UN Command and a serious dislocation upon Eighth Army and Fifth Air Force plans. It would probably have stalled the UN Forces as quickly as the heavier base attack.

The Ships in the Harbor and Its Approaches

21. Inclosure 3 shows that destruction of all or a major part of the vessels in the anchorage would have meant a serious reduction in the total number of cargo, transport, and amphibious vessels in use by the UN Command. Destruction of the army combat units aboard would have meant the loss of more than 25 percent of the X Corps. The two-bomb attack on the surface ships, therefore, would undoubtedly have necessitated a change in the plans which were then about to be executed for the X Corps invasion of Northeast Korea. Moreover, the added damage to the harbor and harbor facilities accompanying such an attack would have helped to make it one of the most promising methods of attack for the enemy to use.

Economic Considerations

22. Even if the enemy had had atomic bombs to employ against Pusan on 16 October, other factors besides purely military ones would have influenced the decision to attack or not to attack. Destruction of the North Pusan harbor facilities would probably not have greatly affected the ROK wartime economy; other harbors in South Korea were available and in use by the Republic of Korea. However, the postwar economy of Korea would have been greatly affected by the destruction of its largest port. The enemy, therefore, in seeking to expel the UN Forces and to bring Korea under Communist exploitation, possibly might have employed atomic military resources in other ways in order

not to damage the Port of Pusan.

Political Considerations

23. A political consideration might have contributed to enemy planning. Atomic bombing of Pusan would have killed and wounded many tens of thousands of Koreans living in the overcrowded city. Such slaughter of assertedly friendly peoples might have been expected to affect adversely the enemy's political and military position by prejudicing his pose as the liberator of these people.

OTHER METHODS OF ATTACK

24. Pusan was vulnerable to weapons other than the atomic bomb. High explosive bombs scattered over the POL dump in Area H and the POL tank farm in Area J would have sufficed to start fires which could have engulfed a major portion of the harbor front and the city itself. Mining of the harbor, especially during periods of such congestion as that on 16 October would have blockaded the port just as was done in World War II by B-29 aircraft operations from Tinian.

CONCLUSIONS

25. a. Pusan represented a very valuable target for enemy attack. The most remunerative components of the target for enemy action were the port facilities and the large fleets of vessels which sometimes occupied the harbor and its approaches. The logistical base was not so remunerative as a primary target.

b. The Pusan target was vulnerable to surprise enemy attack. In such an attack, atomic bombs could have been extremely effective.

c. The most remunerative primary target would have been the large fleet occupying the harbor on 16 October 1950, carrying both cargo and large numbers of combat forces. Atomic bombs could have been used against such a fleet target at Pusan in a way to inflict either great damage upon the port itself or a minimum of such damage.

d. The port facilities would have been a remunerative target for a single atomic bomb.

e. Other weapons usually available to the enemy also could have inflicted severe damage upon the port.

f. Destruction of any or all of the three target components at Pusan, as they existed on 16 October 1950, would have curtailed seriously the operations of UN Forces in Korea. By prompt and determined exploitation of the destruction of the Pusan target, the enemy might have effected a decisive result in his campaign against the UN Forces.

ANNEX 4

INCLOSURE 1

DETAILS OF THE PUSAN TARGET SYSTEM

Physical Facilities of Port; Logistical Supply Dumps, Farms, and Warehouses.

1. The following listing singles out the important facilities of the Port of Pusan, the hospital facilities of the base, and the logistical supply dumps, farms, and warehouses. Each facility listed is readily keyed to Figure 1, by its respective capital letter.

A--POL dump
B--Medical depot (wooden framed building)
C--Hospital (reinforced concrete building)
D--Pier No. 1 (steel framed) (two-story buildings on pier of both wood-framed and steel-framed construction)
  a. Port Commander's Office
  b. Port Operations Office
  c. Navy Headquarters
  d. USS ELDORADO berth
  e. Red Ball Express terminal
E--2nd Logistical Command CP and Railway Station (reinforced-brick and concrete construction)
F--Pier No. 2 (steel framed)
G--Signal depot (two-story, reinforced concrete)
H--POL dump
I--Pier No. 3 (steel framed): QM, Classes I, II, and IV in wooden buildings
J--Oil tank farm (see specifications of standard Army oil tank in later paragraph)
K--USS JACONA
L--Pier No. 4 (steel framed): tanker unloading-terminal
M--Coal
N--QM warehouses, Classes II and IV in wooden buildings
O--Open QM depot, Classes I, II, and IV
P--POL dump
Q--Ordnance: small weapons and weapons parts
R--Crated internal-combustion engines stacked in separated vertical tiers
S--Vehicles
T--Harbor entry control-point

U--Chemical depot
V--Combat ordnance
W--Engineer equipment

Tank Farm

2. The tank farm located at position J is composed of standard 10,000-barrel, bolted steel, above-ground tanks the design of which conforms to the Preliminary Specification, Corps of Engineers, No. GE-501, US Army. Design specifications significant to this study are as follows:

Height--24ft; Diameter--55 ft;
Thickness of first ring plates--0.1875 in;
Thickness of second ring plates--0.1406 in;
Thickness of third ring plates--0.1406 in;
Thickness of top plate--0.1406 in.

Ships in the Anchorage

3. The following sources were consulted for information concerning ships present in the harbor on 16 October 1950:

a. Commander Fleet Activities, Navy No. 3423, Ships Present List, Port of Pusan, 16 October 1950.

b. COMNAVFE and Seventh Fleet, Daily Position Report, Serial: 99-50, 04301 16 October 1950 TG 90.8.

c. Headquarters, 7th Transportation Medium Port, Daily Port Status Report, 17 October 1950.

4. Of the total number of ships present, 48 were in TG 90.8, assigned the task of redeploying the 7th Division and its attached units. The flagship of this Naval Fleet was USS ELDORADO docked at Pier No. 1 as shown in Figure 1. Twenty-three vessels of this fleet were cargo ships, 13 were transports, 10 were LST's and one was an ocean-going tug. They represented a variety of tonnages in their respective classes, and they carried personnel, supplies, and field equipment of the 7th Division with its attached units.

5. Forty-three of the vessels present were cargo ships, tankers, and barges handling equipment and supplies in and out of the port under the 2nd Logistical Command.

6. One vessel, USS JACONA, was a power barge anchored at Pier No. 4 as shown on Figure 1. It supplied a major portion of the electric power consumed by all the services at Pusan.

7. The remaining twenty vessels making the total of 112 were units of the ROK Navy, ROK cargo vessels and one passenger vessel, SS KONGO MARU.

8. All of these vessels were berthed and anchored in the North Harbor, and in its sheltered approach which extends about one mile southeastward beyond the limits shown on Figure 1. Precise information concerning the location of each vessel is not known, except for USS ELDORADO and JACONA, and is not required for this study. A uniform distribution throughout the navigable portions of the entire anchorage may reasonably be assumed for this study.

X Corps Personnel on Board Target Ships on 16 October 1950

9. The embarkation organization is of higher classification and will not be quoted since only the total number of troops on ship board is pertinent to the present study.

Numbers and Locations of Personnel Assigned to 2nd Logistical Command

10. Personnel assigned to the port and to 2nd Logistical Command were billeted and stationed at many places throughout the City of Pusan. Locations of the billets are indicated on Figure 1 by the numbered outlined areas. These locations were specified in detail for this study by G-1 Section of 2nd Logistical Command. Records of the number of personnel present on 16 October were also supplied by G-1 Section. The numbers of personnel assigned to each billet area are given in Table I.

Eighth Army Logistical Supplies Stored at Pusan on 16 October 1950

11. With the cooperation of G-4 Section, 2nd Logistical Command, a rough assessment was made of the logistical supplies at Pusan. Table II covers the more important classes of supplies and roughly evaluates two significant measures of their value to UN Forces as of 16 October, namely the number of days' supply on hand in Pusan and the number of days' supply available to the UN Forces forward of Pusan.

APPENDIX G

TABLE I

NUMBER OF PERSONNEL ASSIGNED TO BILLETS

Numbered Billet Area	Number of Billeted Personnel	Numbered Billet Area	Number of Billeted Personnel
1	150	18	250
2	800	19	200
3	200	20	250
4	200	21	500
5	150	22	100
6	500	23	650
7	200	24	150
8	500	25	200
9	600	26	200
10	200	27	400
11	200	28	300
12	300	29	250
13	400	30	350
14	300	31	150
15	300	32	350
16	350	33	1500
17	500		

TABLE II

TABLE OF LOGISTICAL SUPPLY FOR UN FORCES IN KOREA
16 OCTOBER 1950

Class of Supply	Number of Days' Supply in Pusan	Number of Days' Supply Foward of Pusan
Food	30	10
Medical	10-20	--
POL	10	2
Signal	45	15 (fast moving expendables)
Ordnance	30	--
Chemical	90	15-20
Ammunition	*	--

* The 2nd Logistical Command ammunition dump was not in the immediate target area.

ANNEX 4

INCLOSURE 2

WEATHER DATA, 2143rd AIR WEATHER WING, FEAF SUMMARY FOR SOUTHERN KOREA

On 15 October the weather over southern Korea changed from clear to cloudy. Approximately 1800 hours local time, light rain began. A frontal passage caused poor weather over the entire area on 16 October 1950, with steady rain over southern Korea and the Tsushima Straits, and light rain over Kyushu. Ceilings and visibilities were restricted.

APPENDIX G

THREE HOURLY WEATHER SUMMARY FOR 16TH OCTOBER 1950 AT PUSAN

TIME	VISIBILITY (MILES)	CLOUD AMOUNT	BASE OF LOW CLOUD	ESTIMATED HEIGHT OF TOPS OF CLOUD	WEATHER	WIND DIRECTION AND VELOCITY (KNOTS)	TEMP	DEW POINT
16 Oct 0000I	4	10/10	*2500	20,000	Light Rain	SE 10	67	65
0300I	4	10/10	*1500	20,000	Light Rain	S 10	68	67
0600I	6	10/10	*1000	15,000	Light Rain	SSW 10	74	71
0900I	5	8/10	*2000 SC	15,000	Light Rain	SW 8	75	71
1200I	6	10/10	*7000	18,000	Light Rain	SW 8	75	71
1500I	8	8/10	*2000	18,000		SW 10	75	70
1800I	1	10/10	*1500 SC	20,000	Rain	SW 8	66	64
2100I	3	10/10	*1500 SC	15,000	Light Rain	NNE 15	67	66
17 Oct 0000I*	5	10/10	*2000	14,000	Light Rain	NE 8	65	61

* Asterisk indicates that data are estimated from synoptic map--report missing.

ANNEX 4

INCLOSURE 3

PLANS AND OPERATIONS DIVISION

PLANS BRANCH
PLANS AND OPERATIONS DIVISION
TRANSPORTATION SECTION

1 February 1951

MEMORANDUM TO: Lt Col W. J. Marquette

SUBJECT: Port Facilities in Korea

1. On 29 January 1951, the Operations Research Office of the Department of the Army requested certain information concerning Transportation activities in Korea. A hypothetical situation was outlined in which the United Nations were denied the use of the Port of Pusan on 16 October 1950 and requested the following specific information:

a. Military supply tonnages discharged at Pusan on 16 October 1950?

b. Military supply tonnages discharged at other ports on 16 October 1950?

c. Tonnages that could be discharged at other ports in Korea, including those then not in use?

d. Tonnages that could be discharged over beaches?

e. Tonnages air-landed in Korea on 16 October 1950?

f. Tonnages that could have been landed by air on 16 October 1950?

g. Time required to bring other facilities into use?

h. Number of ships in support of Korean operations and in Pusan Harbor on 16 October 1950?

i. Balance of vessels in use for support of operations in Korea?

2. The information requested was extracted from records available to the Transportation Officer and supplemented by information obtained from COMNAVFE, and follows in the order requested. (All tonnages are measurement tons)

a. Tonnage discharged for United Nations forces in Korea and handled by Pusan:

16 October	Total for October	Average M/T Per Day
3,771 M/T	381,193 M/T	12,700

b. Tonnages discharged at other ports in Korea on 16 October 1950, are not available; however, the total tonnages discharged at other ports in Korea for the month of October were 90,500 M/T, or approximately 19 percent of the total tonnages discharged.

c. The following are maximum capabilities of other ports available at that time in Korea: (included are capacities of ports which at that time were not in use.)

Port	Maximum Daily Capacity
Kunsan	2,000
Mokpo	2,000
Mansan	9,600
Yosu	6,000
Ulsan	2,600
Pohang	4,600
Inchon	20,000
Total capacity	46,800 M/T

It should be noted, however, that the above figures represent maximum capacities, which can be achieved under ideal conditions provided that personnel and units are available to supervise the handling and distribution of cargo. Furthermore, though the above capacities may be reached they could not be maintained due to the limiting factor of port clearance.

d. Though no figures are available concerning beach discharge capacities, COMNAVFE has indicated in reply to a former query that required support could be provided, in spite of existing difficulties which would be magnified if enemy air becomes more active.

e. Tonnages air-landed on 16 October: 575 M/T

f. Tonnages that could have been landed by air on 16 October 1950: 964 M/T.

g. Time required to bring other facilities into use and their initial capabilities are outlined in 3 parts as follows:

(1) Available and in use on 16 October

Inchon 8,000 M/T/day

A maximum of approximately 10,000 M/T/day was discharged subsequent to 16 October.

(2) Available and not in use on 16 October. The following facilities could have been put into operation and maintained the listed tonnages within 1 week:

Port	M/T/Day
Masan	4,000
Yosu	3,000
Pohang	2,300
Ulsan	1,300
Sub-total	10,600

(3) It is estimated that the following additional facilities would have been available on the dates indicated:

(a)	Mokpo	1,000 M/T	24 October
(b)	Kunsan	1,000 M/T	12 November
(c)	Chinnampo	4,000 M/T	11 November

h. Number of ships supporting Korean operations in Pusan Harbor on 16 October: 112

i. 144 additional vessels were in use in support of Korean operations.

3. It should be noted that the figure of 256 vessels used in support of Korean operations does not include those vessels assigned to fleet activities.

WALTER W. DUKE

APPENDIX H

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APPENDIX H 1/

INJURIES TO PERSONNEL; MEDICAL REQUIREMENTS

INTRODUCTION

1. The employment of atomic weapons in support of ground operations will produce casualties in much greater magnitude and in much shorter time than conceivable by conventional weapons. This requires an analysis of the types of injuries incurred in an atomic explosion, an understanding of appropriate medical treatment, and the preparation of adequate medical personnel and facilities to cope with the situation. The problems of instruction or indoctrination of our own troops in methods of protection in the event of atomic attack and the use of safety equipment wherever possible also are issues that must be faced and considered carefully. The problems produced by the large number of casualties and the concomitant medical difficulties are no less important when occurring amongst the enemy than when occurring among friendly troops.

TYPES OF INJURIES FROM ATOMIC AIR BURSTS

2. The large amounts of energy released by an atomic air burst in the form of blast, thermal radiation, and penetrating radiation produce casualties to surviving troops in eight principal categories:

a. Secondary blast traumata are caused by blast-blown debris, collisions with obstacles, collapse of structures, tree falls, and overturned vehicles. These effects are induced principally by the sudden sharp front of blast (the shock wave) and by the following high velocity radial wind lasting about one second.

b. Primary thermal burns are caused by the great intensity of the heat radiated during the first few seconds after the burst from a ball of fire approximately ~~1,000~~ 1,100 feet in diameter. Severe skin burns are produced by

1/ Grateful acknowledgment is made to Major D. H. Behrens, Medical Service Corps, FEC, for his assistance in the preparation of this Appendix.

radiation fluxes of five calories per square centimeter, while clothing chars or flames from fluxes of ten calories per square centimeter.

c. Secondary burns result from general or holocaust fires in combustible debris and flammable materials. (Deaths from oxygen depletion also may occur in some types of forest fires.)

d. Radiation casualties derive from the penetrating gamma radiation delivered during the first dozen seconds following an air burst. Two important points should be noted here: first, radiation sickness, possibly later followed by death, has only limited immediate tactical value since it is a delayed effect occurring after several hours to a few days unless the exposure has been extreme; second, after an air burst, the radiation fission products are carried rapidly aloft to high altitudes in the atomic cloud 2/ so that danger from gamma radiation and radioactive products is negligible on the ground within less than a half minute. However, concurrent precipitation in the immediate area may increase this danger because rain or snow may carry radioactive dusts to the ground. It follows that the area under the air burst point may usually be re-entered immediately, permitting local exploitation of the effect of the bomb. 3/

e. Concussion results from the direct blast wave. Pressures required for 50 percent lethal damage for various animals are given in Table I (obtained from British sources, RC365). It may be noted that the pressure required for killing human beings is far greater than that resulting even at ground zero from a 40 KT atomic air burst at altitudes greater than 1,200 feet (see Figure 4, Appendix A). Medical data on the Hiroshima air burst give some evidence, however, that concussion did produce some injuries.

f. Disorganization casualties are those produced by accidental injuries resulting from causes such as fright, amblyopia (temporary blindness), and loss of control of vehicles.

g. Atomic psychosis results from various causes such as the magnitude of the atomic spectacle, amblyopia, pyrophobia, fear of delayed radiation sickness, and possible (temporary) sterility. This psychosis may be self-induced in poorly indoctrinated troops or may be intensified by

2/ See paragraph 14a, Appendix A.
3/ See, however, paragraph 14b, which discusses radioactive contamination when the ball of fire touches the ground

TABLE I

AIR BLAST PRESSURES REQUIRED TO PRODUCE 50 PERCENT LETHALITY IN VARIOUS ANIMALS AND MAN

Animal	Mass (gms)	50% Lethal Pressure (psi)
Mouse	25	27
Guinea Pig	250	32
Rabbit	1,500	55
Monkey	6,000	100
Goat	20,000	200
Man (Extrapolated)	70,000	430

psychological warfare. 4/

h. Temporary impairment of vision has little tactical significance, except for aircraft pilots and bombardiers. Temporary blindness (amblyopia) caused by flooding of the retina persists for about 20 seconds; loss of night adaptation of the pupil requires perhaps ten minutes for recovery. 5/

The first four of the eight types of casualties from an air burst, as listed above, have definite physical bases which can be used in estimating expected total troop casualties for any given tactical situation. The principal factors determining casualty percentages in terms of radial distance from ground zero are: the TNT (energy) equivalent of the burst; height of the burst; type of cover; kind of uniform; degree of surprise; terrain features; and local weather. The influence of each of these factors is discussed in more detail in Appendix A.

EXPECTED TROOP CASUALTIES BY TYPE

3. Battle casualties by type will have a different distribution for atomic bombs than for conventional weapons. Wounds are the largest number of casualties caused by conventional weapons. Burns usually will account for the largest number of casualties among troops surviving atomic air bursts.

4. Some special attention should be given to casualties from radiation sickness. Reference to Figure 8, Appendix A, and to Chapter 11 of The Effect of Atomic Weapons

4/ See Appendix J
5/ Approximate values determined by experiments with flash-bulbs on ORO personnel.

gives the following information of importance to a consideration of medical problems. For air bursts of a 40 KT weapon at an altitude of about 3,000 to 3,500 feet, everybody exposed within 650 yards of ground zero will die within an hour. From there to about 1,350 yards, everybody exposes will die within two weeks but many will show immediate symptoms. From there to 1,400 yards, exposure will be fatal to at least 50 percent. Between 1,400 and 1,650 yards, symptoms of radiation sickness may not appear for several days. Thus there will be a large number of persons who, although they will most surely die in a short time, will need attention during their last hours. Table II summarizes this information.

TABLE II

RADIATION INJURIES
(Resulting from 40-KT 3000-3500 Ft Air Burst Atomic Weapon)

Dose (Roentgens)	Distance (Yards)	Average Time in Which Symptoms Appear	Average Time of Death	Prognosis
10,000	650	15 minutes	1 hour	Fatal
2,500	1,000	1 hour	4 hours	Fatal
1,000	1,200	4 hours	10 hours	Fatal
600	1,350	2 days	14 days	Fatal to 95% disability certain
400	1,400	7 days	35 days	Fatal to 50% disability certain
200	1,500	14 days	?	Disability certain; death possible
100	1,650	14 days	---	Injury, possible disability
<100	>1,650	---	---	Possible illness, no disability

5. <u>Comparative Casualties, US Troops</u>. US Army casualty experience in World War II and in the Korean campaign, and predicted atomic weapon casualties are summarized in Table III.

TABLE III

US BATTLE CASUALTIES BY TYPE AND STATUS

(In Percent of Total Casualties)

WORLD WAR II		KOREAN EXPERIENCE a/			
Type	Original Status	Initial Status	Final Status	Retd Fr Status	Atomic Weapons (Predicted)
Dead	17.2	15.6	15.6	None	35
Wounded	69.8	67.0	48.8	18.2 b/	45 c/
Missing and Captured	13.0	17.4	15.4	2.0	20
	100.0	100.0	(79.8 +	20.2)	100

a/ As of 27 October 1950.
b/ About 2/3 of wounded return to duty within 120 days.
c/ Radiation sickness casualties generally would not return before 180 days.

The ratio of US Army dead to wounded in battle from present enemy weapons now is roughly 1 to 4. Atomic weapons used by an enemy would be expected to produce a US dead to wounded ratio of roughly 2 to 3, with the expected increase in dead ascribed principally to the more complete coverage of the target area, the increased number of ways in which casualties would be produced, the excessive energy densities released in the neighborhood of ground zero, and the overloading of medical facilities. (Minor burns and injuries, normally requiring only first aid treatment, may become infected.)

An increase in loss by capture would be expected because of the larger gaps and greater disorganization produced by atomic weapons as compared with conventional arms.

Troops returning to active duty from wounded status resulting from atomic secondary blast traumata and thermal burns probably would follow about the same over-all recovery rates as the US army experience for battle wounds inflicted by conventional enemy weapons. 6/ Troops exhibiting immediate radiation sickness (nausea and vomiting) would suffer

6/ See FM 101-10 for rates of return from wounded status.

about 50 percent deaths in two to four weeks and survivors presumably would be discharged on recovery; troops exhibiting delayed clinical symptoms of radiation sickness probably would be evacuated from the theatre.

6. Comparative Casualties, Hiroshima. The ratio of the dead and missing (presumed killed) to the injured population at Hiroshima was almost exactly 1 to 1.

7. Expected Atomic Casualties by Type; CCF and NKA Troops. The expected dead to injured ratio among Chinese Communist and North Korean troops from atomic attacks is assessed at 3 to 2; i.e., 60 percent dead, killed in action plus those who died from wounds, 40 percent wounded. The primary reasons for expecting this ratio are the Hiroshima experience and known CCF and NK medical deficiencies. Table IV gives the present medical organization for Chinese Communist infantry. 7/

TABLE IV

MEDICAL ORGANIZATION IN CCF INFANTRY

(Total Army (Corps) at Full Strength: 38,500, including 5,500 Hq. & Army)

Level & No. of Units	Medical		Others	Stretchers		Personnel Totals	
	Doctors; Nurses	Aid Men		Men	Stretchers	Unit	Corps
Army (1) (Corps)	(Unknown: 50-100)	Total		Bn:300	(Unknown)	375	375
Div (3)	1(?);1	3	25	Co:80	30	110	330
Regt (9)	2(?);2	3	3	Co:100	30	110	990
Bn (27)	---	---	---	Sect:12	12	12	324
							2,019

A comparison of Table IV with Table V shows that medical personnel in NK and CCF infantry, even when they are present in full strength, are only one-third as numerous as in UN infantry. Intelligence reports indicate that they are rarely at full strength; the tendency of the CCF is to curtail this part of their organization at times to dangerously low levels. While it is true that US medical organization is seldom at full strength, the latter condition never exists.

7/ From GHQ, FEC, MIS charts on organization of Chinese Communist Infantry, 1 December 1950.

US Medical Organization

8. The present medical organizations for a US infantry division and corps are given in Tables V & VI 8/

TABLE V

DIVISION MEDICAL SERVICE

1. Organic Medical Support

Unit	T/O&E	Number Per Div	MC	DC	MSC	CH	ANC	WO	EM	AGG
Regimental Medical Co	8-7N	3	6	--	7	--	--	--	199	212
Medical Battalion	8-15N	1	12	18	15	1	--	2	293	341
Medical Detachment Division Arty	6-10N	1	6	--	1	--	--	--	63	70
Medical Detachment Div Eng Bn	5-15N	1	1	--	1	--	--	--	22	24
Medical Detachment Hy Tank Bn	*17-35N-B	1	1	--	1	--	--	--	17	19
Medical Detachment Div Hq	8-72 BN	1	1	--	--	--	--	--	13	14
Medical Section Division Hq	8-71N	1	3	--	1	--	--	--	1	5
TOTAL			42	18	40	1	--	2	1006	1109

*To be checked with T/O&E when available

11. Non-Organic Medical Support

	T/O&E	Number Per Div	MC	DC	MSC	CH	ANC	WO	EM	AGG
Mobile Army Surgical Hospital	8-571CH2	1	14	--	2	--	12	1	97	126
Evacuation Hospital (SM)	8-581	1	30	1	7	1	42	3	251	335
TOTAL			44	1	9	1	54	4	348	461

III. Total Organic and Non-Organic Medical Support

MC	DC	MSC	CH	ANC	WO	EM	AGG
86	19	49	2	54	6	1354	1570

8/ See FM 101-10

TABLE VI

CORPS MEDICAL SERVICE
I. Medical Service, Armored Division (1 per Corps)

Unit	T/O&E	Number Per Div	MC	DC	MSC	CH	WO	EM	AGG
Medical Bn. Armored Division	8-75N	1	16	15	16	1	2	407	457
Medical Det, Armored Inf Bn	7-25N	4	1	--	1	--	--	36	38
Medical Det, Medium Tk Bn Armored Div	17-25N	3	1	--	1	--	--	19	21
Medical Det, Heavy Tk Bn, Armored Div	17-35N	1	1	--	1	--	--	17	19
Medical Det, Armored Div Arty	6-160-1N	1	6	--	1	--	--	55	62
Medical Det, Recon Bn, Armored Div	17-45N	1	1	--	1	--	--	26	28
Medical Det, AAA AW Bn, Armored Div	44-75N	1	2	--	1	--	--	13	16
Medical Det, Armored Engr Bn	5-215N	1	1	--	1	--	--	24	26
Medical Det, Ord Maint Bn, Armored Div	9-65N	1	1	--	--	--	--	7	8
Medical Det, QM Bn, Armored Div	10-45N	1	1	--	--	--	--	6	7
Medical Sect, Hq, Armored Div	17-1N	1	3	--	--	--	1	5	9
Medical Det, Div Hq, Armored Div	17-2	1	1	--	--	--	--	6	7
Medical Sect, Armored Combat Comd	17-20-1N	3	1	--	--	--	--	1	2
TOTAL			43	15	28	1	3	770	860

TABLE VI (continued)

II. Non-Organic Corps Medical Support
(In addition to that supporting infantry and armored divisions)

Unit	T/O&E	Number Per Div	MC	DC	MSC	CH	ANC	WO	EM	AGG
Evacuation Hospital (SM-400 Bed)		4*	30	1	7	1	42	3	251	335
Hq & Hq Det, Bn, Separate	8-22R	1	1	--	5	--	--	1	25	32
Medical Clearing Co, Separate	8-28	1	7	2	1	1	--	3	123	137
Medical Collecting Co, Separate	8-27	1	--	--	5	--	--	--	201	206
Medical Ambulance Co, Separate	8-317	1	--	--	4	--	--	--	86	90
TOTAL			38	3	22	2	42	7	686	800

*One Supporting each inf div; 1 extra per corps

III. Total Corps Medical Support

Unit	MC	DC	MSC	CH	ANC	WO	EM	AGG
3 Inf Divs (incl non-organic support)	258	57	147	6	162	18	4062	4710
1 Armored Div	43	15	28	1	--	3	770	860
Non-organic Corps Medical Support	38	3	22	2	42	7	686	800
TOTAL*	339	75	197	9	204	28	5518	6370

* Including: (1) <u>All</u> medical support for 3 inf divs and 1 armored div.
(2) Non-organic medical support for corps
Not Including: (1) Organic medical detachments for corps units

EFFECTS OF ATTACK ON FRIENDLY TROOPS

9. A four-bomb attack on a corps with a concentration of about 500 men per square mile may be expected to produce about 22,000 serious casualties, of which half will be deaths and the other half incapacitating injuries which will remove the personnel from action for varying extended periods of time. Approximately one-third of the medical personnel may be expected to be casualties, somewhat lower than for other troops because a greater percentage is in rear areas. Similarly, materiel damage will result in attrition of hospital facilities and ambulances. The over-all result may therefore be expected to reduce the available medical personnel to about 4,000 and the bed capacity to about 1,500-2,000. These reduced facilities will be confronted with approximately 11,000 surviving casualties, of whom about 3,500 will be severely injured and about 7,500 will be moderately injured. An additional 4,000 probably will require only first aid treatment. It is quite obvious, therefore, that medical facilities as high as corps level will be overtaxed. Within a few hours, however, evacuation to army will relieve the situation considerably.

10. At division level, field medical installations are not to be regarded as bed capacity. The principal function of these units is to supply first aid and prepare casualties for evacuation. Any attempt to use these facilities as "beds" will interfere seriously with their regular functions. Hence, the bed capacity given in paragraph 8 does not include divisional medical installations.

US MEDICAL SUPPLY PROBLEMS

11. Medical supplies will probably not be available in sufficient quantities for the type of injury prevalent as a result of atomic air bursts, namely, burns. Supplies at advance sections of field depots at corps headquarters are usually within 3-5 hours driving time of the front line, but here too the distribution of supplies in different categories is based on casualty distributions resulting from conventional weapons. Even at army depots, perhaps 24 hours distant, while Class II supplies (bandages, etcetera) would be available in sufficient quantities, Class I supplies (ointments, etcetera) will be in short supply. While enough blood plasma for perhaps 500 casualties might be present at the front lines, storage facilities for whole blood would not be available. The results of whole blood and plasma delivery by air-drop have not yet been evaluated; considerable development work must still be done on flexible-type containers (probably plastic) before reasonable success in air-drop delivery can be attained. Delivery of

present containers by L-4 or L-5 aircraft or helicopters would limit single deliveries to about 50 pints.

12. Under existing conditions, it would take 12-24 hours to deliver air-landed medical supplies to using units in Korea. Air-drop could reduce this time no more than 2-6 hours largely because a great deal of time is lost in preparation for air-drop. However, delivery time would take only 2-3 hours if supply packages specially fitted for atomic warfare could be prepared in advance for air delivery and stored at such southern air bases as Ahsiya.

APPENDIX H

ANNEX 1: INSTRUCTION AND SAFETY EQUIPMENT FOR FRIENDLY TROOPS

1. In order to protect friendly troops from the effects of atomic weapons, it is necessary to establish an organization specialized in radiological defense. Troops should be indoctrinated, and radiological monitors with detecting equipment should be trained.

2. The organization and training of UN forces in Korea to the degree required for safety have not been accomplished. Although radiological officers have been appointed for all divisions, and FEC directives order appointment of other members and alternates, only two radiological defense officers have received adequate training. Phases I and II of the atomic energy indoctrination course have been completed, and Phase III has been completed in some commands. But the bulk of US forces in Korea have not been indoctrinated, and there has been practically no "indoctrination" of other UN forces.

3. No training program has been provided for radiological officers, radiological non-commissioned officers, radiological monitors or repairmen, except that provided by SR 350-80-1.

4. Estimates of materiel requirements based on the Department of the Army plan for radiological defense for UN forces in Korea are approximately 1,600 survey instruments and about 5,300 pocket dosimeters. Minimum requirements of survey instruments to provide one per chemical section and one per regiment, and one pocket dosimeter for each member of radiological survey teams would be 83 survey instruments and 528 pocket dosimeters for all UN forces.

5. Stocks in the area are inadequate for the complete Department of the Army plan. There are at present 44 survey instruments and 40 pocket dosimeters in FEC, of which 20 and 28 respectively have been issued; the rest are in depots.

6. The preceding estimates seem to be too large to implement quickly, and there is some question whether

instruments of the caliber of these instruments are really required in the field except for radiological defense teams A rugged survey instrument with an accuracy of ±25 percent should suffice to detect danger areas and these instruments could be produced at small cost and in large numbers in a very short time. Such instruments would obviate the necessity of maintenance. If they are inoperative, they can be discarded.

7. On the other hand, indoctrination of friendly troops to promote safety and prevent panic is mandatory. Once policy decision has been reached by higher authority to use the atomic bomb, but Phase III indoctrination has not been completed, it is recommended that the following be done:

a. All commanding officers from battalion level up should be briefed in the proper procedure to be followed for the protection of UN forces in the immediate vicinity of target. This briefing is to be accomplished by personnel of the Joint Atomic Advisory Groups* in conjunction with regimental and divisional commanders and staffs, and should be completed not later than five days after command decision has been reached. (A time of two weeks between command decision and employment is assumed.)

b. Within four days of being themselves briefed, all battalion commanders, with the assistance of a member of the Joint Atomic Advisory Group, will instruct their company or battery commanders in the accepted procedure for the safety and protection of personnel and equipment. The company or battery commanders will then instruct and indoctrinate their troops with regard to the proper procedure and precautions which are to be followed for protection against the various effects of atomic weapons.

*See Paragraphs 9-10, Appendix F

APPENDIX I

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APPENDIX I

COMPARISON WITH OTHER WEAPONS*

INTRODUCTION

1. The atomic bomb has never been employed in support of ground operations. This is a serious limitation on the reliability with which such use can be anticipated and increases the demand that all pertinent information be assembled to answer the question: What can atomic weapons do for ground operations that cannot be done by the other weapons available?

2. Selection of appropriate weapons is usually complicated by what may be termed substitutive weapons. Most targets, depending upon the circumstances, can be destroyed by more than one available weapon. Depending on its location, a tank can be destroyed by tactical aircraft using napalm, rocket, bomb, machine gun; by opposing tanks; by mines; by artillery or mortar fire; or by infantry using bazookas or even satchel charges. Similarly, a few thousand troops in bivouac killed by <u>one</u> atomic explosion <u>might</u> be killed by <u>many</u> sorties of tactical aircraft. If one atomic explosion can produce 50 percent casualties on one division of infantry, the same result can presumably be achieved by <u>many</u> assorted other weapons already available. The purpose of this appendix will be: first, to establish bases of comparison, and then, to compare substitutive weapons for attacking area targets.

BASIS FOR COMPARISON

3. The following criteria may be applied in attacking the problem of comparing area weapons:

a. Area damage related to:

(1) Accuracy of delivery.
(2) Errors in determining position of target.
(3) Target size.

---

*Prepared by W. L. Whitson

b. Saturation effect of producing damage in minimum time.

c. Tactics employed--is it desired; to take the offensive against numerically superior enemy forces; to hold a defensive line; or perhaps assure the capability to evacuate friendly forces in any contingency?

d. Cost, including production as well as purely operational costs.

4. Another criterion of critical importance which must enter into the command decision but which obviously may not be discussed in this paper is that of the availability of atomic weapons. The employment of the atomic bomb for strategic purposes against cities, factories, and industrial complexes is an important use which, because of a not unlimited stockpile, is competitive to at least some degree with the employment of atomic weapons in support of ground operations.

Limitations of Current Capability

5. In the present study, most of the emphasis has been placed on the tactical use of high atomic air bursts. It is pertinent to point up some of the limitations of current capabilities by listing some of the difficult targets for an air burst explosion.

a. Armor. A tank, the vehicle itself, is a poor target for high air bursts. Reference to Figure 24, Appendix A, shows that only light damage is expected from 250 yards to 2,200 yards from ground zero.* However, since the top armor of a tank is thin, personnel inside receive a lethal dose of gamma radiation at nearly as great a range as if they were in the open. Except in an area of about 1/4 square mile, most tanks may be operative after an atomic explosion and personnel may be capable of operating them pending radiation sickness.**

b. Command Post. A command post in a tent or building above ground has comparatively poor protection except against the thermal radiation from an atomic explosion. Owing to their importance, it is well to consider that underground command posts can with comparatively little effort be made almost invulnerable to an air burst atomic ex-explosion. Thermal radiation is, of course, no problem; the

*Except for tanks which may be set on fire; see Appendix A, paragraph 99
**See Appendix H, Table II

top of the shelter can be reinforced so that the blast will not collapse it; and, by judicious design, shielding from gamma radiation can be made adequate except for a burst almost directly overhead.

c. Infantry in Trenches. From the casualty curves in Appendix A it is apparent that a slit trench affords fair protection for infantry. A deep slit trench is adequate protection except within about 2,500 yards from a 40-KT airburst, particularly if the infantryman is in the trench at zero time and lies flat on the bottom.

6. This relative invulnerability of some common targets to an air burst is discussed for two reasons:

a. To distinguish current capability from future capability for the purpose of present operations.

b. To indicate that in the near future more effective atomic weapons should and will be available for ground operations.

WEAPONS SYSTEMS TO BE COMPARED

7. The following weapons are to be compared:

a. Medium bombers (strategic air).

b. Tactical air.

c. Infantry-artillery-armor team.

8. a. Tactical atomic bombing is functionally similar to B-29 bombing, particularly carpet bombing. In effectiveness, atomic bombing is more likely to compare with the current operations of tactical aircraft and the infantry-artillery-armor team.

b. However, there is an important advantage in the use of the atomic bomb in that, since the number of sorties to cover a given area is very much less than for conventional bombing by B-29 or tactical aircraft, the total time, particularly the time during which the action at the target takes place, is less. This is important for targets which last only a short time and for targets which can speedily take protective measures even if forewarned only a few minutes.

COMPARISON WITH CONVENTIONAL BOMBING BY B-29

Interdiction

9. Much of the effort by B-29 aircraft has been to bomb centers and routes of supply. In the next section of this appendix the capabilities of atomic bombs for interdiction operations will be discussed in connection with the use of tactical aircraft for this purpose.

Close Support

10. Two carpet bombing missions have been accomplished in Korea so far.* If the effectiveness of these operations is questioned, it is on the following bases:

a. The maximum effort which can be made with the three groups of B-29 aircraft available in the theater.

b. The area to be bombed--the first target was 20-30 sq mi in area, the second approximately 2 sq mi.

c. The adequacy of intelligence information to define the target for the time during which it is to be bombed.

11. In Annex 1 of this Appendix the required concentrations of the various types of ammunition to produce a certain casualty rate are computed. Table I is a summary of the requirements. The information given is the basis of a simple analysis to show under what circumstances the atomic bomb should be used by B-29 aircraft instead of conventional bombs.**

12. Some estimate of the effect of producing casualties is necessary. It will be assumed here that 30 percent casualties produced in a random manner in any organized unit on the ground will be decisive. That is, 30 percent casualties

* January 1951.

** It will be noted that in Table I, only a 500-pound GP bomb with a VT fuze is considered for comparison with the atomic bomb. Actually, under some circumstances, as noted in Annex 1, a 500-pound fragmentation cluster is better. However, since it operates with an instantaneous fuze, the fragmentation cluster is not effective against personnel even in a very shallow foxhole, and as a result almost all casualties are produced against personnel in the open. In a carpet bombing attack most personnel will have time to get into a foxhole or to find a slight depression in the ground which offers good protection.

to the enemy will be decisive in allowing friendly forces to take the offensive or to maintain an adequate defense. Further, 30 percent casualties to forces held in reserve would necessitate regrouping and reorganizing and, hence, is also considered decisive.

13. There are three groups of B-29 aircraft composing the FEAF Bomber Command now available in the Far East Command. On maximum effort basis, perhaps 70 aircraft can operate one sortie each on alternate days. A sustained effort would reduce the number of sorties per day considerably. Table I gives the maximum effort of this force of B-29 aircraft in dropping HE bombs, which may be summarized by the following:

a. A total of 70 B-29 aircraft can bomb a target area of about 4 square miles in one day, and in so doing produce 30 percent casualties on personnel half of whom are prone in the open and half of whom are in shallow trenches.

b. A total of 70 B-29 aircraft can bomb at the rate of about 2 square miles per day as maximum sustained effort in producing the above effect.

c. This effort may be utilized to hit as many separated targets as required; i.e., only the total area is involved.

d. One to two targets per day, 1 square mile each in area, is maximum sustained effort.

e. One target of 3 to 4 square miles may be attacked on a single day.

14. In contrast, if the atomic bomb is used and a capability of dropping 10 bombs per day is assumed, the following is the capability:

a. A total of 10 B-29 aircraft can bomb a maximum target area of more than 160 square miles per day producing more than 40 percent casualties under the conditions assumed.

b. As a sustained effort 10 targets of 1 to 16 square miles in area may be attacked per day.

15. If we apply the criterion of 30 percent casualties, current B-29 capabilities in the Far East Command with respect to conventional bombs, and an assumed capability to drop 10 atomic bombs per day, the following is concluded:

TABLE I

COMPARISON OF REQUIREMENTS FOR VARIOUS TYPES OF MUNITIONS FOR AREA BOMBING OF PERSONNEL*

Target Area	Ammunition	Percent Personnel Casualties	Ammunition	Tons	Sorties
1 sq mi	A-bomb	100	1	--	1 B-29
	500-lb GP with VT fuze	30	752	188	19 B-29 376 F-51 or F-80
4 sq mi	A-bomb	99	1	--	1 B-29
	500-lb GP with VT fuze	30	3,010	752	75 B-29 1,480 F-51 or F-80
16 sq mi	A-bomb	53	1	--	1 B-29
	500-lb GP with VT fuze	30	12,020	3,010	300 B-29 5,920 F-51 or F-80

*Casualties caused by atomic bombing are for a 40-KT bomb, air burst at 3,000-3,500 feet, on a day when the limit of visibility is 12 miles, and it is specified that 50 percent of the personnel are exposed in the open (vulnerability Class A) and 50 percent in slit trenches (vulnerability Class B). Casualties due to fragments from a 500-lb GP bomb specify that 50 percent of the personnel are prone in the open and 50 percent in deep slit trenches.

TABLE II

EFFECT OF A-BOMBING
ERROR ON CASUALTIES

Target Area	Bombing Error (Yards)	Personnel Distributions: ½ in Foxholes, ½ Exposed in Open	Personnel Distributions: All in Foxholes	Personnel Distributions: All Exposed In Open	Percent Casualties*
1 sq mi	0	X	X	X	100
1 sq mi	1,000	X	--	--	99
1 sq mi	1,000	--	--	X	100
1 sq mi	1,000	--	X	--	98
4 sq mi	0	X	--	--	99
4 sq mi	0	--	X	--	98
4 sq mi	1,000	X	--	--	90
4 sq mi	1,000	--	X	--	83
16 sq mi	0	X	--	--	53
16 sq mi	0	--	X	--	43
16 sq mi	1,000	X	--	--	50
16 sq mi	1,000	--	X	--	43

*40-KT bomb, 3,500 feet height of burst, 12 mile limit of visibility.

a. Conventional bombs may be employed for any number of targets totalling on the average not more than 1 to 2 square miles per day.

b. In any situation in which it is required to bomb one or more targets totalling more than 3 to 4 square miles on any day conventional bombs may not be efficiently employed.

c. A target up to 16 square miles in area may be attacked with a single A-bomb.

d. Maximum capability of atomic bombing compared with carpet bombing is 40 to 50 times as much area, and 5 to 6 times as many targets per day of 1 square mile or more in area.

Effect of Bombing Errors

16. a. B-29 bombing in Korea has so far given an estimated CPE of 150 yards at altitudes of approximately 10,000 feet. Carpet bombing done under these circumstances should be very effective.

b. The same is true for dropping atomic bombs from an altitude of approximately 20,000 feet. At this altitude the expected bombing error for visual bombing is 300 to 500 yards CPE. Table II shows the effect of an error of 1000 yards in bombing on the percent casualties produced. It should be observed that for the largest target considered, 16 square miles, the average percent casualties within the area do not drop to 30 percent.

Effect of Dispersal or Movement of the Target

17. Table III is introduced to show that the effect of the target moving 2,000 yards is more serious, particularly when all personnel are in foxholes.

18. With the assistance of Tables II and III some important observations can be made relative to the problem of intelligence.

a. Assume that during the time between a decision to carpet bomb an area of 1 square mile and the actual bombing of the target the personnel move as a group a distance of 1 mile. The result is zero casualties from conventional bombs.

b. Assume next that the target becomes dispersed so that it covers five times the area by the time the carpet

APPENDIX I

TABLE III

EFFECT OF MOVEMENT OF TARGET

Target Area	Movement of Targets (Yards)	½ in Foxholes, ½ Exposed in Open	All in Foxholes	All Exposed in Open	Percent Casualties*
1 sq mi	0	X	X	X	100
1 sq mi	2,000	X	--	--	80
1 sq mi	2,000	--	--	X	90
1 sq mi	2,000	--	X	--	70
4 sq mi	0	X	--	--	99
4 sq mi	0	--	X	--	98
4 sq mi	2,000	X	--	--	70
4 sq mi	2,000	--	X	--	59
16 sq mi	0	X	--	--	53
16 sq mi	0	--	X	--	43
16 sq mi	2,000	X	--	--	45
16 sq mi	2,000	--	X	--	34

*40-KT bomb, 3,500 feet height of burst, 12 mile limit of visibility.

bombing is done. The result is 1/5 as many casualties or, in the situations assumed in Table I, 6 percent casualties.

c. Now compare these results with atomic bombing. Tables II and III show that the reduction in casualties is not very important except for one or two cases (total casualties remain more than 30 percent) for either a movement of the target as a whole or its being dispersed to occupy more area. This is true until the area of the target exceeds 16 square miles. For example, suppose intelligence has spotted a target 1 square mile in area and that when the atomic bomb is actually dropped, the personnel composing the target have dispersed to occupy 16 square miles and the center of the group has shifted 2,000 yards. Even so, 45 percent casualties will result for men half of whom are in foxholes and the other half exposed in the open.

d. It is concluded that for targets up to 16 square miles in area the intelligence problem of pinpointing the target and the problem of target movement before operations are both much less severe when the atomic bomb is employed.

Saturation Effect of Maximizing Firepower

19. When the rate of damage to an operation exceeds the rate at which repairs can be accomplished, a trend is produced which if allowed to continue must result in failure of the operation. Saturation types of attack are designed to push the operation to the "breaking point" even before ordinary facilities for repair can be brought to bear, thus causing the failure of the operation in minimum time and with minimum effort. This principle is well established in the use of artillery preliminary to an offensive infantry attack by friendly forces or to break up an enemy offensive.

20. a. It is desired to apply this same principle in order to contrast carpet bombing with atomic bombing. It is considered that many times in line actions one point in the line can be singled out because of its importance in the operation, and, if this is so and the area involved is not too large, a carpet bombing attack is indicated. If the particular position in the line is critical and the attack is successful, the result may be decisive. The build-up and recognition of such points in line action is problematical.

b. Contrast with the foregoing the possibility of applying such attacks simultaneously at many points along a line. For example, suppose a perimeter is 50 miles in length and that there is the capability of dropping ten atomic bombs spaced at five minute intervals. These ten atomic bombs would produce a point to point average of 40 percent casualties to a distance of 4 miles behind the lines and, if dropped at the right time, would be decisive in allowing expansion of the perimeter or in protecting it against an enemy offensive.* Actual experience with atomic bombing is the prerequisite to success in the design of such operations. It must be evident, however, that atomic bombs, in their ability to produce casualties simultaneously over very large areas, are good weapons for saturation operations of this type and vastly superior to the carpet bombing of a much more restricted area.

Cost of Production and Operations

21. In the Korean campaign, with the opposition of Chinese Communist forces greatly superior in numbers, the cost of operations is probably of relatively little importance. However, a demonstration that for area targets, atomic bombing is less costly than carpet bombing will lend emphasis in the right direction.

22. a. At the end of the last war it was estimated that the combined maintenance, production, training, and operating cost of heavy bombardment by aircraft was $29,000 per ton of bombs. A more recent estimate which allows principally for the difference in the value of the dollar is $70,000 per ton of bombs. It will be assumed here that the combined cost in Korea is $50,000 per ton of bombs. Figures 1 and 2 show the relative cost of A-bombing and conventional bombing for various areas of targets.

b. The most economical situation from the point of view of conventional bombing has been set forth in Annex 1. A total of 10½ B-29 aircraft carrying 105 tons of clustered fragmentation bombs are required to produce 30 percent casualties to personnel half in trenches and half in the open in an area of 1 square mile, and the total combined cost is $5,500,000.

23. The cost of production of one atomic bomb will be assumed to be $2,000,000 as compared with $2,000 per ton for HE bombs. One B-29 sortie delivering 10 tons of bombs costs $500,000. The cost of the 40 HE bombs usually carried is $80,000 and will be neglected in comparison with the cost of an A-bomb. Therefore, the cost of one sortie carrying one atomic bomb is $2,500,000. If the B-29 actually

*See Annex 3, Appendix B for an analysis of perimeter defense.

FIG. 1
APPENDIX I

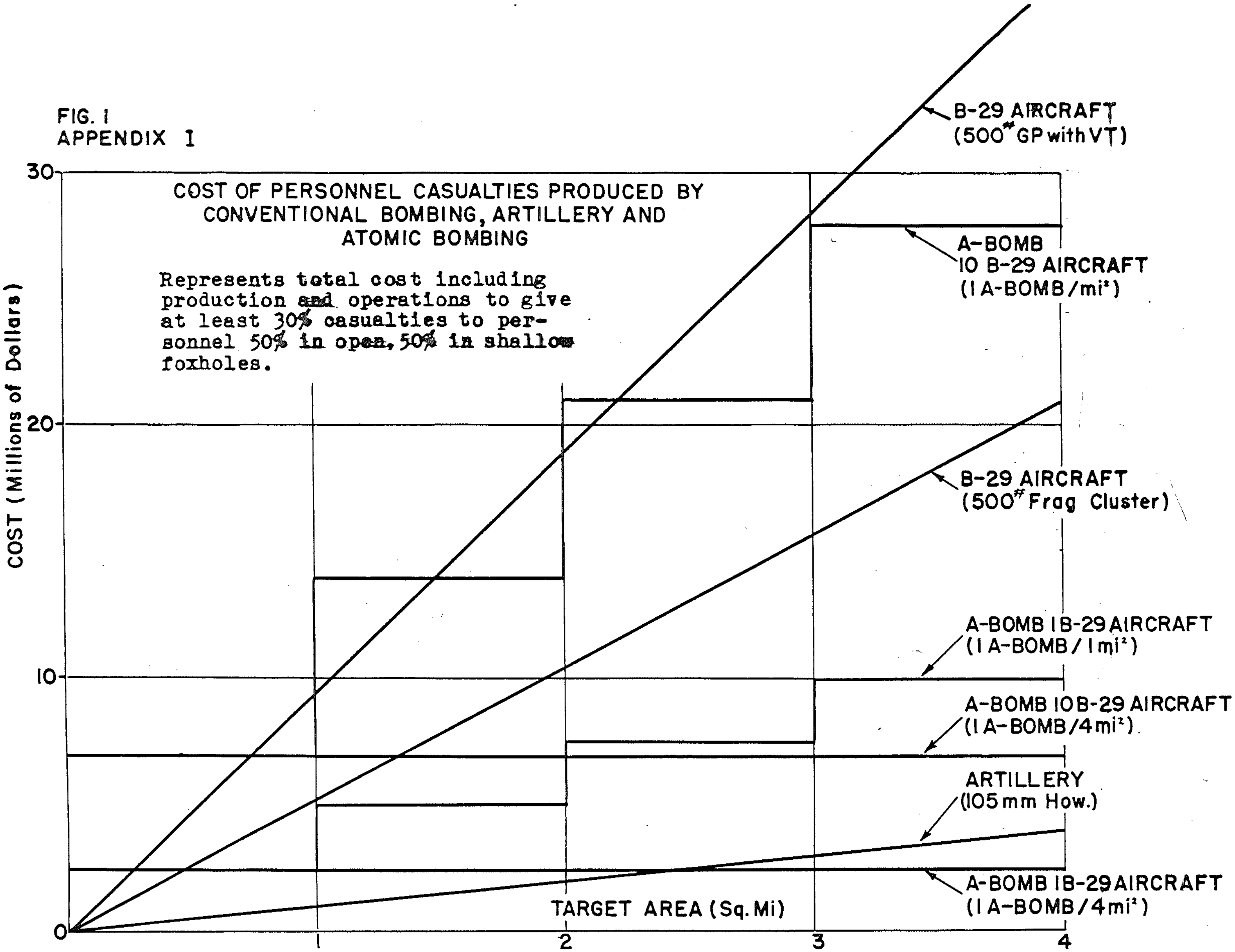
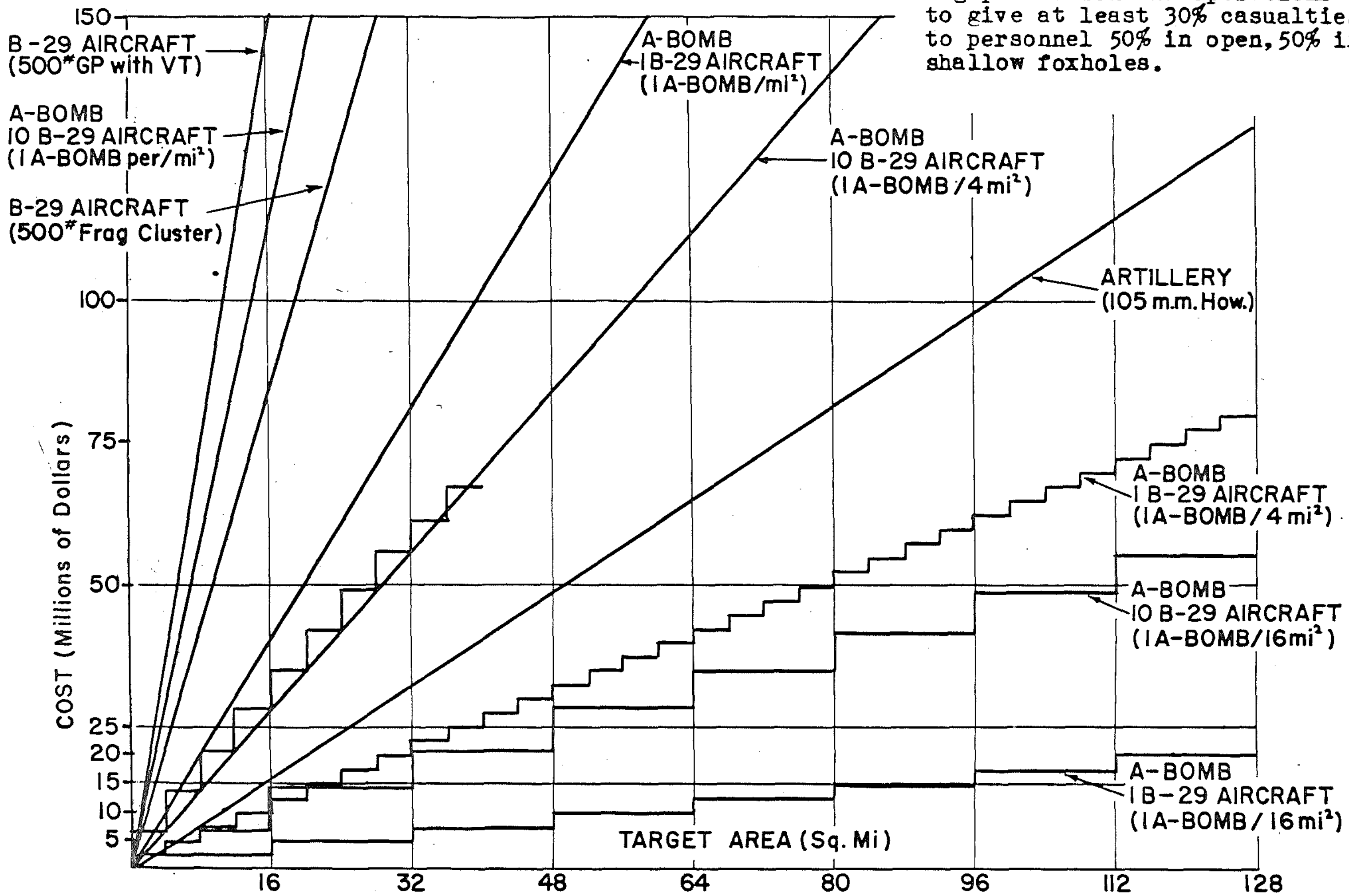


FIG. 2
APPENDIX I

COST OF PERSONNEL CASUALTIES PRODUCED BY CONVENTIONAL BOMBING, ARTILLERY AND ATOMIC BOMBING

Represents total cost including production and operations to give at least 30% casualties to personnel 50% in open, 50% in shallow foxholes.



carrying the atomic bomb is escorted by several other B-29's not carrying a payload, the operational cost goes up correspondingly.

24. The cost of producing personnel casualties by area artillery fires is computed in Annex 2 of this appendix. For the case of personnel half in the open and half in shallow trenches, the cost for 105-mm howitzers is $1,000,000 to fire 9,250 projectiles (about 150 tons) by 6-7 battalions over a period of one hour. A further consideration of area shelling by artillery is given in paragraph 35.

25. Figures 1 and 2 include the case where one B-29 carrying an atomic bomb is escorted by 9 others with no payload. The number of escort aircraft selected is pure assumption and has no bearing on known operational planning.

26. The relative costs involving areas 4 square miles or less is given in Figure 1 and in Figure 2 for larger areas. Several conclusions can be obtained:

a. A target of 1 square mile or less in area can be attacked with significantly less cost by an atomic bomb only if there are few B-29 escort aircraft.

b. A single target much larger than 1 square mile in area can be attacked by an atomic bomb with much less cost than conventional bombing.

c. Targets averaging 4 square miles in area can be attacked by atomic bombs for less cost by a factor of 4 if escorted and a factor of 7 if unescorted.

d. Targets averaging 16 square miles in area can be attacked by atomic bombs for less cost by a factor of 12 than the least expensive conventional bombing if escorted and a factor of 40 if unescorted.

e. For targets averaging 4 square miles, atomic bombing is nearly twice as expensive as artillery for a 9 B-29 escort and 2/3 as expensive with no escort.

f. Targets averaging 16 square miles are attacked by atomic bombs for less cost by a factor of 12 than by the least expensive conventional bombing if the bomber is escorted, and by a factor of 40 if it is unescorted.

g. For targets averaging 16 square miles atomic bombing is less expensive by a factor of 2 than artillery when the bomber is escorted and a factor of 8 when it is unescorted.

Interdiction

27. For the most part, the military targets in rear areas which are important to logistics are either line targets--railroads, highways--or small area targets of less than one square mile. Because of their nature, and because they are numerous, such targets have not in general been considered suitable targets for atomic bombs. If atomic bombs are stockpiles for tactical use, there will no doubt be targets which because of unusual size or importance would be considered suitable. Troop concentrations, either in bivouac or moving up to the front, if numbering several thousand and concentrated in an area less than 4 miles square, would certainly be a good atomic target. If the troops could be seen or were quartered in known buildings, they might be attacked by the weapons now available to tactical air. However, if they cannot be seen and it is merely known they are in a relatively large area, tactical aircraft cannot destroy them with conventional weapons.

28. If suitable concentrations of men and equipment are to be found in rear areas, it is pointed out that as soon as atomic attacks are made on them, appropriate defensive measures would be taken. The appropriate defense against atomic bombs in the rear area is dispersal. It may not be necessary to concentrate men and equipment in rear areas to such an extent that they become suitable bomb targets.

Close Support

29. In contrast with the rear areas, it is necessary to concentrate men and equipment in the forward areas and in the front line. When these concentrations can be seen from the air, they are bona fide targets for tactical air.

30. Area Targets. The weapons of tactical aircraft are designed for delivery on specific targets with best possible accuracy. Rockets, napalm, bombs, machine guns, are all designed to be aimed at targets that can be identified from the air. In some instances, of course, the target itself is not seen--as a tank hiding in a haystack or driven inside a house.

31. Consider the problem of concentrations of troops and equipment known to be in a restricted area but not identifiable from the air as a target. That it is not feasible to use tactical aircraft for area bombing is apparent in Table I of this Appendix in which it is noted that, carrying two 500-lb GP bombs with VT fuzes, 376 sorties of F-51 or F-80 aircraft are required to carry the 752 bombs

necessary to cover a target one square mile in area. The tactical aircraft available to FEC could attack about one such target a day. The same arguments apply here as are set down in the preceding section where carpet bombing is compared with atomic bombing to determine capabilities of destroying targets of various sizes. It is instructive to note that a personnel target of optimum size for an atomic bomb (4 miles square) would require nearly 6,000 sorties of tactical air to produce equivalent effect by area bombing.

COMPARISON WITH INFANTRY-ARTILLERY-ARMOR

32. a. It is difficult to compare the destruction caused by an atomic bomb with the combined fire power of infantry, artillery, and armor. The atomic bomb over-kills a considerable fraction of the area. Infantry, artillery and armor aim for the most part at specific small targets.

b. So far as the war in Korea is concerned, the problem is one of supplementing existing forces. Presumably the atomic bomb is capable of counter-balancing a numerical superiority of forces in the field. This can be accomplished, however, only when the enemy can be forced to concentrate. When the enemy cannot be forced to concentrate, the only utility of an atomic weapon would be for chance targets of opportunity set up carelessly or unavoidably by the enemy.

33. Nor is it advantageous from all points of view to use the atomic bomb for all area targets. Cost is an example. The cost of area fire by artillery is treated in Annex 2 of this appendix. A comparison with other weapons is shown in Figures 1 and 2 and artillery is highly competitive with the other weapons. It is only when the area of individual targets exceeds 3 square miles that atomic bombing becomes less expensive than artillery.

34. However, certain qualifications must necessarily be applied to area artillery fire: range, mobility and timing. For example, if a target 1 square mile in area is within 6,000 yards (the maximum range considered in Annex 2 with TSQ fuze; use of the VT fuze would allow extension of maximum range to 12,000 yards) of the three battalions of 105-mm howitzers belonging to a particular division, the area could be shelled in a little more than two hours producing 30 percent casualties on personnel half in the open and half in shallow foxholes. The following observations are pertinent:

a. If the target were beyond range, mobility would be a factor. In particular, if the target were beyond

105-mm range or the forward positions of friendly infantry, an air attack would be necessary.

b. If the target were beyond range and if in the time necessary to displace artillery forward, the target would be gone, alternate means of attack such as air would be considered.

c. If the target could move without detection or could protect itself during the 2 hour period of firing required above, the problem of rate of fire would become important.

35. The 54 105-mm pieces composing the three battalions could fire at the rate of 72 rounds per minute covering 300,000 square feet (a circle approximately 100 yards in diameter). Utilizing all possible firepower of appropriate range (including other calibers) in the same division, or adjoining divisions or corps, it would be impossible to decrease the above time by more than a factor of 10. So the minimum time to cover a 100-yard diameter circle is six seconds and to cover one square mile would require at least twelve minutes. Compare this with the time required to do the corresponding job with 500-lb GP bombs carried by 19 B-29 aircraft (Table I, preceding). Flying at a ground speed of 250 mph a B-29 flies one mile in 14 seconds. If the aircraft dropped simultaneously, the time, from first to last explosion on the ground, would be less than 20 seconds. In Table IV bombardment by B-29 and by massed artillery fire are contrasted with the instantaneous effect of the atomic bomb.

TABLE IV

TIME REQUIRED TO COVER A TARGET OF ONE SQUARE MILE, TROOPS 50 PERCENT IN OPEN AND 50 PERCENT IN SHALLOW FOXHOLES

Method	Effort	Time Required (Approximate)	Casualty Rate
A bomb	1 B-29 aircraft	3 seconds*	100%
500-lb GP Bomb	19 B-29 aircraft	20 seconds	30%
105-mm Shell	54 105-mm howitzers	12 minutes	30%

*Time required for blast wave to travel its first mile. Also, substantially all the thermal radiation is emitted in 3 seconds.

36. If a line is established and the enemy is forced to concentrate to attack, destruction from atomic bomb explosions could be decisive. The method of ground forces at the present time is to hack at the enemy in a piecemeal fashion. By contrast, an atomic explosion is capable of neutralizing in one blast a military unit as large as a division. Such a simplification of the problem of ground tactics will no doubt be extremely helpful if and when numerous atomic weapons are used in support of ground forces. It is, of course, dangerous to do more than speculate about the literal effect of atomic weapons on ground tactics.

CONCLUSIONS

37. To summarize the comparison of atomic bombing with other weapons:

a. The necessity for employing the atomic bomb depends on the plan of attack and comparison of its effectiveness with other weapons depends on that plan.

b. If friendly and enemy forces are approximately equal, the employment of the atomic bomb will be decisive. Against numerically superior forces the effectiveness will depend on the specific superiority and the number of bombs employed.

c. As a weapon for area, the atomic bomb is far more effective than carpet bombing for corresponding effort. The possible area coverage from maximum effort with atomic bombs exceeds by far that possible by carpet bombing.

d. Atomic bombing is complementary to tactical air, particularly for bombing air targets on the ground which, even though their approximate location is known, cannot be seen from the air.

e. Atomic bombing can be complementary to the infantry-artillery-armor forces, and therefore may counterbalance a numerical deficiency in these forces.

APPENDIX I, ANNEX 1:

ATTACKS ON TROOPS WITH B-29 AIRCRAFT*

FORCE ESTIMATES

1. a. Table I contains force estimates for the use of the B-29 aircraft in carpet bombing against troops in various dispositions. The data are based on the achievement of 30 percent casualties over an area of one square mile.

b. The dimensions of the bombed area are based on the assumption that the individual aircraft will drop all bombs in train in one pass. If the target shape is not compatible with the dimensions given, it is possible either to vary the tactics and have the aircraft make more than one pass, or to vary the intervalometer setting. Either method will result in less uniform bomb distributions and somewhat reduce the over-all effectiveness.

c. Care must be taken in scaling to larger areas owing to the increased difficulty of maintaining coordination between aircraft groups.

WEAPONS EFFECTIVENESS

Basic Equation

2. The effectiveness of the weapons is based on weapons data presented in Chapter 19 of Vol. 1, Div. 2, NSRD Report Effects of Impact and Explosion. The measure of effectiveness is the mean area of effectiveness (MAE) for incapacitation of personnel. The MAE's listed in Table II are taken from Chart 19 of the report cited above. The MAE's listed in Table III were taken as representative and the calculations in this report based upon them. The fuzes in all cases will be assumed to operate effectively 85 percent of the time.

3. a. The calculations are based on the equation:

$$F = 1 - e^{-0.85MD}$$

*Prepared by Lloyd D. Yates

in which

F = fraction of casualties in a homogeneous population,
M = mean area of effectiveness*,
D = number of bombs/(bombed area), with area expressed in the same dimension as in M.

This equation, in effect, accounts for the overlapping of bombs under conditions of random distribution. If the flight spacing and intervalometer settings are accurate and the ballistic dispersion is small, the actual fraction of casualties may be increased by a small amount.

b. This equation may be applied directly for troops in deep trenches, troops in shallow trenches, and troops in the open in a prone position with consideration of the appropriate weapon.

The 500-lb GP Bomb with VT Fuze

4. a. When a fraction of the troops are in the open and the remainder in trenches, a suitable equation may be derived as follows. Consider the effectiveness of 500-lb GP bombs with VT fuzing:

$$f_a = 1 - e^{-0.85M_aD}$$

$$f_b = 1 - e^{-0.85M_bD}$$

in which

f_a = fractions of casualties among troops in the open,
M_a = MAE of the 500-lb GP bomb with VT fuze against troops in the open,
f_b = fraction of casualties among troops in shallow trenches,
M_b = MAE of the 500-lb GP bomb with VT fuze against troops in shallow trenches.

b. Now if

a = fraction of troops in the open,
b = fraction of troops in shallow trenches,
c = fraction of casualties of total troops,

*The number 0.85 is based on the assumption that only 85 percent of the fuzes will operate effectively.

then

$$af_a + bf_b = c.$$

c. Noting that

$$a + b = 1.00,$$

and making the proper substitutions, we arrive at:

$$\frac{1-c}{a} = e^{-0.85M_aD} + \frac{1-a}{a}\, e^{-0.85M_bD} \quad . \; . \; . \; . \; . \; . \; . \; . \; (1)$$

In using equation (1) note that when given a, c, M_a, and M_b, one may solve for D by trial and error.

d. If M_a and M_b are in square feet, the

$$\text{Number of bombs/square mile} = 28\text{x}10^6 D\ ,$$

and with 40 of the 500-lb GP bombs per plane,

$$\text{Number of planes/square mile} = \frac{28\text{x}10^6 D}{40}\ . \quad (2)$$

<u>The 500-lb Fragmentation Cluster Bomb</u>

5. a. The fragmentation cluster which is effective only against the troops in the open may be used to produce a higher casualty rate among the troops in the open and thus achieve the desired over-all casualty rate if the fraction of troops in the open exceeds the desired over-all casualty fraction. The actual force requirements may be determined as follows:

$$f_a = 1 - e^{-0.85M_fD},$$

$$f_b = 0,$$

in which

M_f = MAE of the 500-lb fragmentation cluster against troops in the open.

b. Hence

$$e^{-0.85M_fD} = 1-\frac{c}{a}\ ,$$

and

$$D = \frac{\text{Ln}\ (1-\frac{c}{a})}{-0.85M_f}$$

c. Therefore, with fragmentation clusters the

$$\text{No. of bombs/square mile} = \frac{28\times10^6 \ \mathrm{Ln}\ (1 - \frac{c}{a})}{-0.85M_f}$$

and with 32 of the 500-lb fragmentation clusters per B-29 bomber the

$$\text{No. of planes/square mile} = \frac{28\times10^6 \ \mathrm{Ln}\ (1-\frac{c}{a})}{-0.85M_f(32)} \quad \ldots(3)$$

Selection of Munition

6. a. Now if equations (2) and (3) are equated and solved for D, the result may be substituted in equation (1) and a final equation obtained showing the conditions under which the number of planes required is the same when either 500-lb fragmentation clusters or 500-lb GP bombs with VT fuzes are carried. The equation resulting from these operations is:

$$\exp\left[1.25\frac{M_a}{M_f}\mathrm{Ln}\left(1-\frac{c}{a}\right)\right] + \frac{1-a}{a}\exp\left[1.25\frac{M_b}{M_f}\mathrm{Ln}\left(1-\frac{c}{a}\right)\right] = 1-\frac{c}{a} \quad \ldots(4)$$

b. A plot of equation (4) is shown in Figure 1. When the percent of troops in the open is assumed and the desired over-all casualty rate given, this curve shows which munition will require the smallest number of planes. As an example, if 30 percent casualties are desired, the 500-pound GP bomb with VT fuzing requires the least number of planes when less than 35 percent of the troops are in the open and conversely the use of fragmentation cluster will result in smaller force requirements if more than 35 percent of the troops are exposed. The figures given in Table I, it will be remarked, bear this out.

7. Curves of the type presented in Figure 2 may now be readily obtained. The breakeven point having been determined from Figure 1, equations (2) and (3) may be applied and the minimum number of B-29's to produce a certain casualty rate may be plotted as a function of the percent of troops in the open.

8. The use of the instantaneous nose fuze has not been considered except for the situation in which all the troops are exposed in the open, when the fragmentation cluster is much more effective. The 500-pound GP bomb with the instantaneous nose fuze has approximately the same MAE against

APPENDIX I
ANNEX I

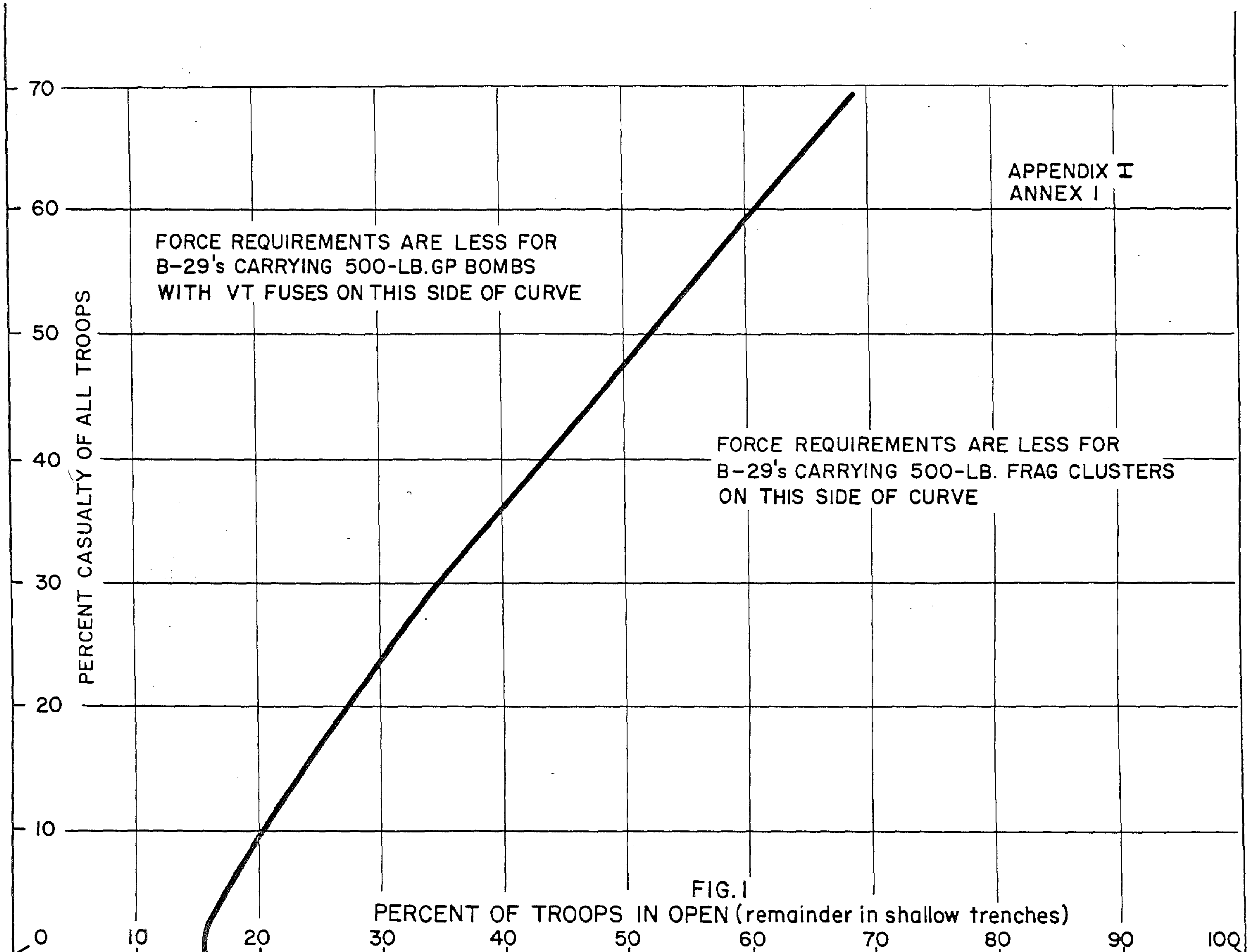


FIG. 1

APPENDIX I
ANNEX I

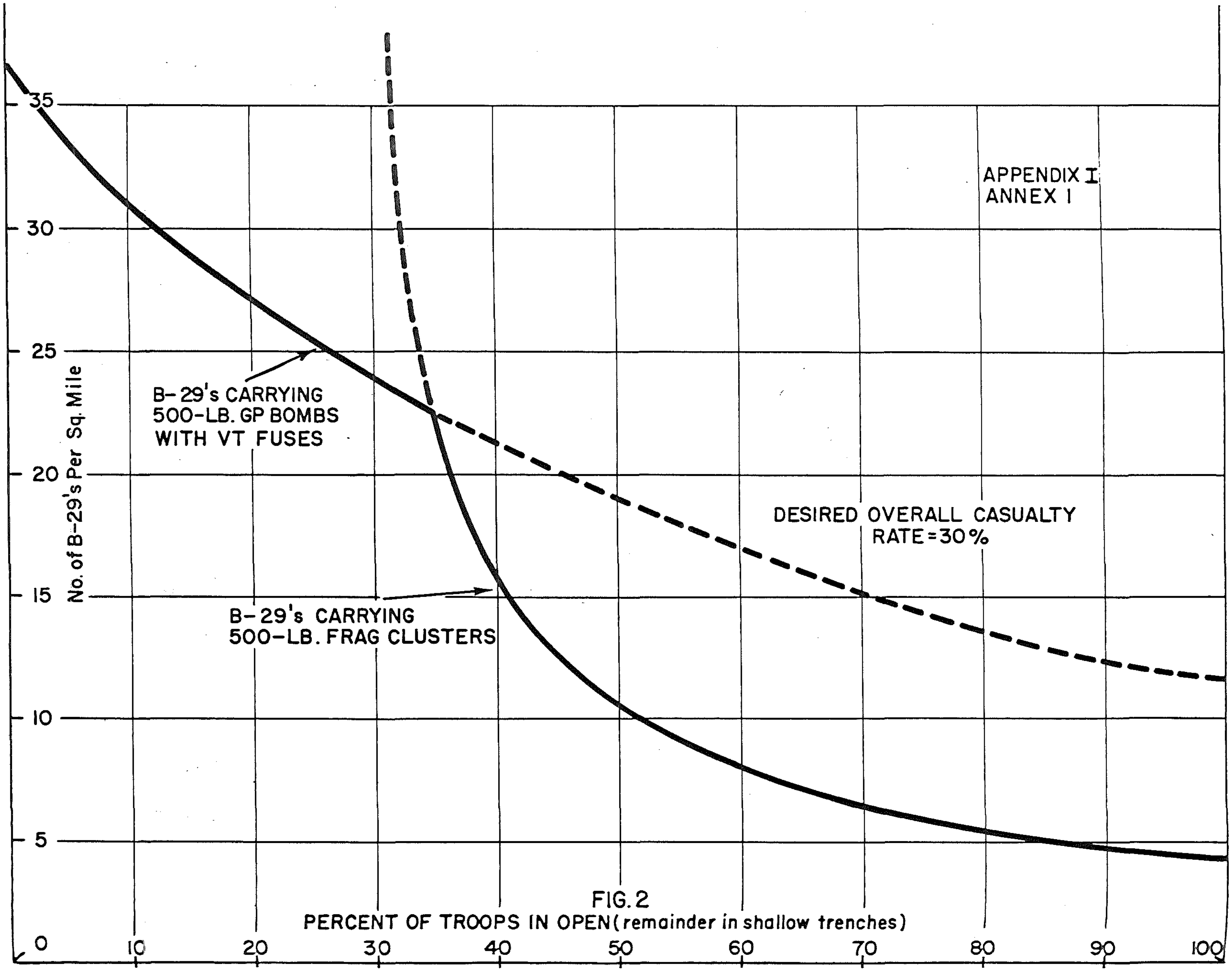


FIG. 2
PERCENT OF TROOPS IN OPEN (remainder in shallow trenches)

troops in the open as the 500-pound GP bomb with VT fuze, but the effectiveness drops off virtually to zero when the troops have the protection of a trench.

Other Considerations

9. There are several other factors that have not been included in the analysis and which may influence the planning of operations.

10. The fragmentation cluster is not popular with crews because it is a more dangerous ammunition to handle and carry than general purpose bombs. If the mission is diverted after take-off owing to weather or changes in intelligence information, the fragmentation cluster will have little value against other targets. The effectiveness of this ammunition falls off rapidly when the bomb is dropped from altitudes greater than 10,000 feet, and thus an operational limitation is imposed on the B-29. This factor can become serious if heavy AA fire or interception is encountered.

11. a. There exists some doubt that the VT fuze operability will attain the value of 0.85 as assumed.

b. If a bomb with VT fuze is to be dropped from above 10,000 feet, an arming delay must be employed to prevent an excessive number of "earlies." A standard tail fuze is employed to cause detonation on impact in the event that the arming delay or the fuze itself does not function.

c. The VT-fuzed bomb cannot be dropped through an undercast or broken clouds unless the arming delay is set to prevent arming until the bomb is clear of the clouds.

d. In the event of diversion to other targets after take-off, the arming wire must be cut or the arming delay must be employed to prevent arming of the VT fuze and so render the ammunition effective against other targets.

e. The VT fuze will change the ballistic characteristics of bombs somewhat, particularly when dropped from above 10,000 feet.

TABLE I

FORCE ESTIMATES FOR CARPET BOMBING
(for achieving 30 percent casualties)

Target Type	No. of B-29's	Type of Bombs	No. of Bombs	Intervalometer Setting	Dimensions of Bomb Area*
Troops, Deep Trenches	59	500-lb GP-VT	2360	109 ft	6430x4350 ft^2
Troops, Shallow Trenches	36.8	500-lb GP-VT	1470	138 ft	5100x5500 ft^2
Troops, in Open & Prone	11.8	500-lb GP-VT or Inst Fuze	471	243 ft	2870x9710 ft^2
Troops, in Open & Prone	4.1	500-lb Frag Cluster	131	460 ft	1890x14,800 ft^2
Troops, 50% in Open, 50% in Shallow Trenches	10.5	500-lb Frag Cluster	337	289 ft	3030x9250 ft^2
Troops, 50% in Open, 50% Shallow Trenches	18.8	500-lb GP-VT	752	179 ft	3620x7700 ft^2

* See footnote next page.

low Trenches	18.8	500-lb GP-VT	752	179 ft	3620x7700 ft^2

* See footnote next page.

TABLE I (continued)

Target Type	No. of B-29's	Type of Bombs	No. of Bombs	Intervalometer Setting	Dimensions of Bomb Area*
Troops, 40% in Open, 60% in Shallow Trenches	15.9	500-lb Frag Cluster	510	234 ft	3730x7500 ft^2
Troops, 40% in Open, 60% Shallow Trenches	21.2	500-lb GP-VT	847	182 ft	3850x7260 ft^2
Troops, 35% in Open, 65% Shallow Trenches	22.3	500-lb Frag Cluster	714	198 ft	4410x6340 ft^2
Troops, 35% in Open, 65% Shallow Trenches	22.5	500-lb GP-VT	900	177 ft	3960x7170 ft^2
Troops, 32% in Open, 68% Shallow Trenches	31.6	500-lb Frag Cluster	1010	167 ft	5250x5340 ft^2
Troops, 32% in Open, 68% Shallow Trenches	23.2	500-lb GP-VT	927	173 ft	4030x6950 ft^2

* The first figure is the frontal width of the bombed area measured perpendicular to the direction of flight. The area in all cases is 28×10^6 ft^2 or one square mile.

TABLE II

MAE FOR INCAPACITATION IN SQUARE FEET

Target	Ground Burst Inst. Fuzing		500-lb GP Bomb VT Fuzing	
	British 500-lb MC	Cluster of 18 US 20-lb Frag	Air Burst, 10 Ft Height	Air Burst, 36 Ft Height
Men, deep trenches	-----	--------	5,200	4,800
Men, shallow trenches	-----	--------	5,600	8,000
Men, prone, unshielded	24,000	90,000	25,000	24,000

TABLE III

MAE IN SQUARE FEET

Target	500-lb GP Bomb Inst. Fuze	500-lb GP Bomb VT Fuze	500-lb Frag Cluster
Men, deep trenches	----------	5,000	------------
Men, shallow trenches	----------	8,000	------------
Men, prone, unshielded	25,000	25,000	90,000

APPENDIX I, ANNEX 2:

ATTACKS ON TROOPS WITH 105mm HOWITZERS*

AREA PERSONNEL TARGETS

1. Artillery has been used consistently as an area weapon against personnel with good results. In general artillery has not been massed to give concentrated coverage of areas as large as one square mile, but in World War II it was used in such a fashion at least several times.

2. The purpose of this annex is to consider the ammunition requirements and corresponding costs if the 105mm howitzer is used to produce 30 percent casualties over an area of one square mile. An estimate will be made of the number of battalions required to deliver the ammunition.

3. The calculations will be made for targets of two types:

a. Troops in the open, no shielding, prone position; 105mm howitzer (M2A1 or M4), HE w/ SQ PD fuze.

b. Troops in 10^{o} foxholes; 105mm howitzer (M2A1 or M4), HE w/ TSQ fuze, air burst at optimum mean height.

Number of Shells Required

4. The shell densities required to produce 30 percent casualties for each target are taken from TM 9-1907. The number is based on ranges of 3,000 to 6,000 yards.

5. a. For target 3a, defined above, 2.5 shells are required per 10,000 square feet, or 7,000 shells per square mile. Each projectile weighs 33 pounds, and thus 115 tons of ammunition per square mile are required.

b. For target 3b, defined above, 4.1 shells are required per 10,000 square feet, or 11,500 shells per square mile. This is the equivalent of 190 tons of ammunition per square mile.

*Prepared by Lloyd D. Yates

Cost

6. A detailed analysis should be made of the present costs to produce and deliver ammunition based upon current experience. The Ordnance Department estimates the production cost of a complete round as $0.81 per projectile pound, or $1,600 per projectile ton. It is estimated that the logistic costs of delivery are approximately 3 times this value. The total cost of production and delivery is therefore estimated at $6,400 per ton. Thus the cost for target 3a, is $740,000 per square mile; and for target 3b, is $1,200,000 per square mile.

Time Required

7. Staff Officers' Field Manual FM 101-10, states that the 105mm howitzer can be employed at an average firing rate (for periods of time less than 6 hours) of 80 rounds per gun per hour in preparation fire. Thus 5 battalions have the capability of delivering the ammunition required for target 3a, over a period of approximately one hour, and 8 battalions have the capability of delivering the ammunition required for target 3b, over a period of approximately one hour.

RECAPITULATION AND COMMENT

8. The following table summarizes the foregoing:

	Target 3a Troops, Open, No Shielding, Prone Position, 105mm How HE w/SQ PDF	Target 3b Troops in 10° Foxholes, 105mm HOW HE w/TSQ, Air Burst at Opt Mean Height
Projectiles per sq mi	7,000	11,500
Tons of proj per sq mi	115	190
Bns to cover 1 sq mi in 1 hr	5	8
Ammunition cost to cover 1 sq mi	$740,000	$1,200,000

9. Detailed calculations could be performed to determine the number of shells required when 50 percent of the troops are in the open and 50 percent in 10° foxholes (the

equivalent of shallow foxholes). However, the mean of the tabulated figures will be approximately correct and within the limits of precision of the calculations. Hence, for troops who are 50 percent in the open and 50 percent in 10° foxholes, 9,250 projectiles (with TSQ fuzes) per square mile are required--or about 150 tons per square mile at a cost of about $1,000,000. In one hour, 6 to 7 battalions can deliver the required ammunition.

10. a. The relative values of time and VT fuzes are discussed in paragraph 24 of FM 6-40. The following extract summarizes the material in a general fashion:

> "The VT fuze does not replace time fuzes but supplements them at the longer ranges of the weapons and in high angle fire. Present powder train fuzes are most effective to about 15 seconds of burning. Beyond that point the advantages are reduced."

b. The additional cost of the VT fuze (about $90 per round) must be weighed against the value of extending the range of the weapon and has not been considered in this study.

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APPENDIX J*

INDIRECT AND NON-MATERIAL EFFECTS OF THE USE OF ATOMIC WEAPONS IN CLOSE SUPPORT OF GROUND OPERATIONS

PROBLEM

1. The problem is to estimate:

a. What indirect or non-material effects will arise out of the use of atomic weapons in close support of ground operations.

b. To what extent these effects will be matters of military concern.

FACTS

2. a. If there are civilians in the damage area when an atomic weapon is employed, there will be civilian as well as military casualties.

b. If the area chosen is in a friendly country, the civilian casualties may be principally friendly civilians.

3. The enemy has a capacity to reconsider and to modify his tactics and dispositions in the light of fresh battle experience.

4. Given the limitations of past test data available to either side, each occasion on which the weapon is used will serve to expand the knowledge of tactical and other effects for both sides.

DISCUSSION

The Limits of Military Concern

5. Military concern presumably attaches only to those elements among the indirect and non-material effects which:

*Prepared by G. S. Pettee

a. Are directly affected themselves by the military decisions; or

b. Will in turn have a direct effect upon further military plans and operations.

6. Among the indirect effects, furthermore, there will be some psychological and political effects that are not open to analysis or prediction on any firm basis, but which must be regarded as highly controversial and speculative in character. That such effects are sure to occur may be worthy of notice, but any serious effort to predict precisely the effect might well be wasted.

The Kinds of Indirect and Non-Material Effects

7. a. The indirect and non-material effects that may be expected from the tactical use of atomic weapons can be classified roughly under nine types. These types are listed below, and a brief discussion of each one follows:

(1) Civilian casualties.
(2) Defeat imposed through exploitation.
(3) Extrication of our forces from a critical situation.
(4) Changes in enemy tactics or dispositions.
(5) Psychological effect on enemy troops.
(6) Effects on minds of enemy political cadres.
(7) Impact on the international situation.
(8) Effect on enemy estimate of our supply of the weapon.
(9) Possible change in the deterrent value of our known capability to use the weapon at some unknown time.

b. Among these nine types of effect, those which are of most immediate military concern are presumably the first five.

Civilian Casualties

8. The numbers of civilians destroyed in the course of the employment of atomic weapons will be largely affected by the decisions made about targets. These decisions -- which are military decisions -- should therefore consider the number of civilians in the target area.

9. The ratio of enemy military personnel destroyed to civilian personnel destroyed may vary widely. An enemy division may be crowded at an opportune time in a small town. Or a few thousand men may be concentrated in a small area,

but in the midst of a large city. Targets that are suitable on all other grounds might often involve from 5 percent to 75 percent civilian casualties.

10. The area where the weapon will be used is likely to be a friendly country. The civilians involved may therefore be accounted as friendly civilians. The occasion thus may not be parallel to the past uses of the weapon in war, when civilian casualties were entirely enemy civilians.

11. The military authorities who make the target decisions will also be the military authorities who have to continue the war in the region involved, and who have to maintain their relations with the government of the country. The psychological impact of the use of the weapon upon the population and government of the country will therefore be of military concern.

Exploitation

12. The use of an atomic weapon may well be associated with a situation in which there will be an opportunity to impose defeat on an enemy force much larger that the one directly hit by the weapon. In such a connection the destruction of one or several command posts may assume a value beyond the numbers of personnel or equipment that may be destroyed. Terrain features over a wider area than the target will have a bearing on exploitation. The choice of targets will be affected by the possible measures to exploit the occasion.

Extrication

13. The extrication of our own forces from a critical situation may be considered the reverse of exploitation. Instead of imposing a definite defeat on the enemy, such action would seek to prevent the defeat he hopes to impose on us. A situation imposing a probable requirement for disengagement and withdrawal would bring considerations of much the same order to bear upon the criteria of target selection.

Enemy Tactical Changes

14. a. After the initial use of the weapon, within a short time, the enemy may be expected to deduce the nature of our target criteria.

b. The enemy has shown a capacity to review, analyze and appreciate battle experience, and to derive and apply tactical lessons in a short time.

c. Suitable targets for atomic weapons will probably become less frequent after the initial attack. They will also probably be more difficult to identify by intelligence methods. Consequently, the degree of steady improvement of our own intelligence proceedures may set the limit of tactical decisiveness, for the weapon.

15. a. The enemy has two means by which to make the occurrence of suitable targets less frequent.

(1) One means is to avoid attractive concentrations, in preparation for attack, in bivouac, or on routes of movement and supply.

(2) The other means is to seek proximity to our own troops.

b. The effect of the first means upon his plans and operations may have important military effects which may be largely of advantage to us. To the extent that he attempts to maintain proximity to our forces he may lose much in lateral mobility. He might also invite penetration and envelopment tactics by us.

16. In short, the first use of the atomic weapon will, in all probability, be followed by modifications of enemy dispositions and tactics which may:

a. Make the further usefulness of the weapon a subject of fresh technical and tactical problems.

b. Have effects upon tactics which may work favorably for us.

c. Present a fresh intelligence problem for us, quite different from the initial one.

Psychological Effects on Enemy Troops

17. a. The psychological effect on enemy soldiery is highly problematical. There are, of course, no direct test data.

b. However, such a parallel use as that of gas at Ypres in 1915 may offer some light. There a panic was caused in a Moroccan division. Heavy casualties were incurred by the Canadians and British, but there was no panic among them.

c. Given the general disregard of death among Asiatics as compared with Americans, it might come to be accepted as a normal hazard of war. Before such acceptance, however, there might be local or temporary fear reactions that would pay off largely in terms of the ratio of defeated to destroyed.

Effects on Minds of Enemy Political Cadres

18. The impact on the enemy's leading cadres of political type, that is, government and party, would be one of embitterment. The cadres of world Communism have now had three decades in which to adjust themselves to fighting against superior materiel. They have what amounts to pre-conditioned reactions to such events as a defeat imposed through superior enemy material, mixed reaction of masochistic pride in their own sufferings and magnified hatred of their enemy. Such reactions do not make them incapable of calculation or caution. They are quite capable, of course, of adopting the tactics of a general political retreat, or of intensified offensive, on the cold-war front. The world communist system of which they are a part has many means and methods ready for either line.

Impact on the International Situation

19. The use of the weapon, even in a single instance, will have what are generally referred to as "profound repercussions" on the international situation. It will immediately indicate to all concerned, that the US is ready to raise the stakes in the Korean game. Unless there is an open announcement that the intention is simply to facilitate extrication of our forces, it will be taken to mean a higher level of determination to win in Korea than we had previously demonstrated. This will naturally enter into enemy and other calculations as a fresh fact bearing on the situation, and will alter the estimate of the situation in key minds, including those of enemy governments, in Peking and Moscow. This may lead to a backing down, or to intensified effort to win the stakes of prestige that are involved.

Effect on Enemy Estimate of Our Supply

20. If we use the weapon, one minor effect is sure to be that it will afford the enemy some data which he will take as bearing upon the size of our stockpile. How he will interpret it is unpredictable, but it might be assumed that he will judge our use as more or less liberal with regard to both numbers used and type of target attacked.

Possible Change in Deterrent Values

21. a. The use of an atomic weapon will expose it to

the enemy as well as to our own scrutiny for the acquisition of new data on its effects. This fresh information may lead him to raise or lower his estimate of its value.

b. The deterrent value of the superior capability of the US to use atomic weapons has been regarded as important in restraining the enemy from being even more aggressive. If this deterrent value is actually important, then anything that would make him estimate the weapon more highly or less highly, will also increase or reduce this deterrent effect.

Influence of Indirect Effects Upon the Problem of What Is An Acceptable Target

22. It is apparent that several of the indirect effects which have been discussed will have a bearing upon the choice of targets and upon the question of what is the minimum acceptable target for attack.

23. a. A normal concept of a minimum acceptable target may hinge, as elsewhere remarked in this report,* upon the numbers of personnel and equipment destroyed at lesser cost than by other military means.

b. If civilian casualties are considered as a factor to be minimized or avoided, a distorting consideration is introduced. Presumably one would not hesitate to attack a target where one might destroy 10,000 enemy military and only, let us say, 500 friendly civilians. Yet one might be "reluctant" to attack another with the same yield in enemy military but involving, let us say, 50,000 friendly civilians. (The figures are meant to be illustrative only. Different ratios can be chosen at will.) It remains that at some extremes in terms of this ratio a target would or would not be acceptable.

civ/mil ratio 20/1 OK but not 1:5

24. Exploitation or extrication each introduce additional factors in target selection, calling for consideration of the relation of the possible targets to the whole battle situation. Such considerations cannot be discussed except in general and speculative terms at this stage, but the requisite data for concrete and practical consideration will presumably be on hand when immediate command decisions on the use of the weapon are to be made.

25. The probability of changes in enemy tactics or dispositions after the initial use of the weapon means that one kind of surprise may be possible on the first occasion

* See Appendix I

and never equally possible thereafter. This tends to emphasize the importance of withholding the initial attack, from the first isolated targets of opportunity, for an occasion when the attack may hit either one exceptionally good target or an exceptionally good complex of targets. It may also mean that on the first occasion, when a good target complex has been found, it may be worthwhile to extend it to targets which would, individually considered, be regarded as below the normal standard for the minimum acceptable.

26. The influence of all such considerations upon the selection of targets will appear more orderly if they are regarded as correction factors to be applied to a standard minimum acceptable target.

CONCLUSIONS

27. One of the indirect effects resulting from the tactical employment of atomic weapons which will be of military concern will be the probable number of civilians destroyed.

28. Exploitation of the situation created by the weapon, or extrication of our own or friendly forces from a critical situation by means of the weapon, may be the major objectives of the use of the weapon.

29. The probable quick change of enemy tactics and dispositions after first use will probably deny future use a part of the surprise element which may be achieved at first.

30. Such factors will have a bearing upon the choice of targets, but they cannot be predicted in advance and must, therefore, be regarded as factors to be considered at the time of actual decision.

31. The initial tactical use of atomic weapons will have very important political and psychological effects.*

RECOMMENDATIONS

32. The number of civilians in the target area should be given consideration in the processes by which intelligence judgment on the target and command decision to attack it are reached. this got lost in summary

33. Due emphasis should be given, in considering the first use of the weapon, to the probability that it will be the one best chance to attain full surprise effect.

* See note, next page, and also Annex 1.

Note: The reader is referred to Annex 1, a translation of a North Korean document on atomic power, used for indoctrination purposes. This booklet gives no information on atomic safety, but stresses political and psychological aspects as follows:

a. Attempts to show that all important discoveries in atomic energy have been made by Russian scientists.

b. States that the USSR has emphasized the exploitation of atomic power for the benefit of man, while capitalistic countries, especially US, have subverted Russian atomic discoveries for purposes of war, domination and destruction.

c. Infers that communist countries have nothing to fear from US atomic weapons, since USSR with her superior science will make superior weapons available for defense and retaliation when the necessity arises.

APPENDIX J, ANNEX 1

GENERAL HEADQUARTERS
FAR EAST COMMAND
MILITARY INTELLIGENCE SECTION, GENERAL STAFF
ALLIED TRANSLATOR AND INTERPRETER SECTION*

201897 Printed booklet titled, "Data for Natural Science Lecture, Atomic Power Series No. 7," issued by Propaganda Dept, Cultural Training Bureau, 1950 (This document, originally in Korean, was translated by G-2 ATIS.)

Captured: Place and date unknown

Recd ATIS: 1 Feb 51

Full translation:

(TN The symbol * indicates a McCune-Reischauer transliteration of the original ONMUN.)

Table of Contents

1. Atomic Structure.

2. What is Atomic Energy?

3. Fission of Atomic Nucleus.

4. Utilization of Atomic Energy.

5. Leading Contribution of the USSR to Natural Science and Atomic Energy Research.

1. Atomic Structure.

It is well known that a matter is composed of molecules

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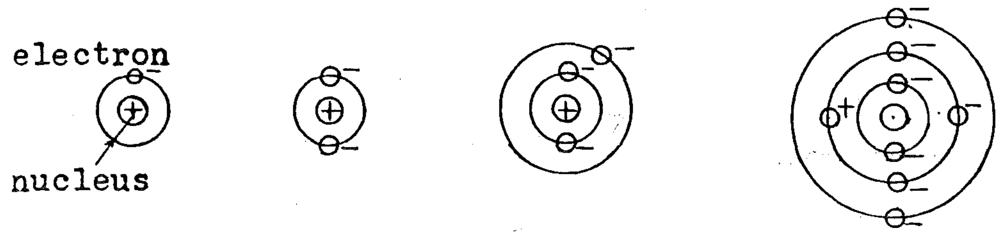
* When separated from this document, the separate classification of this Annex is CONFIDENTIAL. Both original authors' and translators' errors are copied in the Annex.

which is composed of two or more atoms. This fact was discovered about two thousand years ago. Scientists at that time considered that all matter was composed of individual units containing special characteristics of the matter, and that such units were basically incapable of further division. They called this unit "atom." The term atom means further division is impossible. Among scientists, such conception of atom prevailed throughout the 19th century. They were unable to make any further progress in the atomic theory. At the outset of 20th century, scientists discovered through general development of physics that the atom could be further divided, and consequently past atomic theory became outmoded.

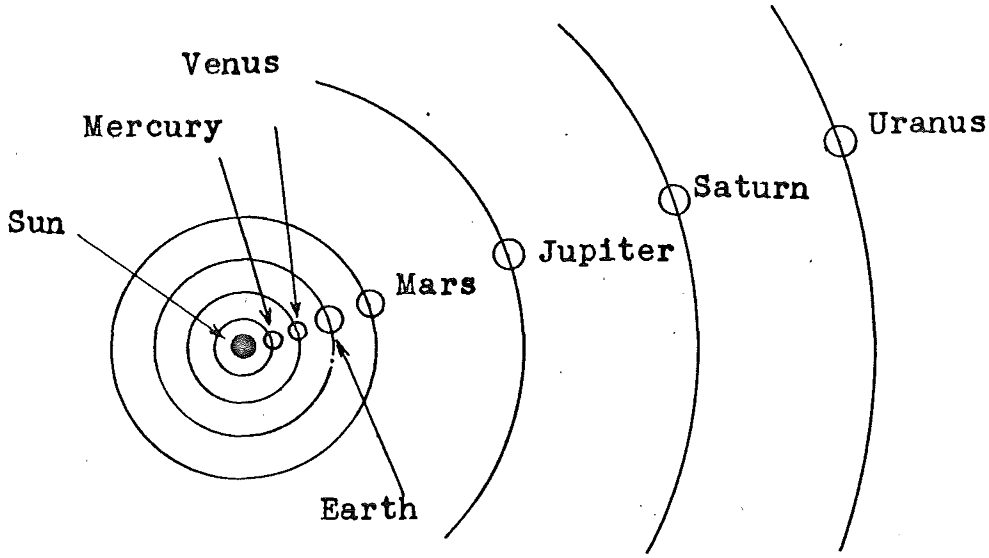
In 1919, RUTHERFORD succeeded in artifically splitting the atom. Thereafter, in less than half a century the study of the atom developed rapidly to the present day atomic science. Hence, presently how can we explain atomic structure? There is a so-called atomic nucleus in the center of an atom which is the largest, both in size and in mass, of any other composing unit of the atom. There is another small unit which is revolving around the nucleus and is negatively charged. This unit is called an electron. Within the atom there is but one nucleus. The number of electrons, however, vary from 1 to 98, depending on the atom. The hydrogen atom is the simplest of the atom in structure, having but one electron.

The helium atom has two electrons, the oxygen eight, and uranium has the most, with 92 electrons. Electrons rotate in groups on their own orbit around the nucleus and form an "Electron Shell." The figure below shows the rotating electron orbit.

Hydrogen Atom | Helium Atom | Lithium Atom | Oxygen Atom



As the above figure shows, the atom containing three or more electrons has two or more electron orbits. The oxygen atom has two electrons in the extreme outside orbit, four in the middle, and two in the inside orbit. The electron which rotates on its orbit away from the nucleus, has the greater potential. The relationship of mass in electron and nucleus; the mass of nucleus is much larger than that of electron. Therefore, the mass of electron is generally not considered whenever entire mass of atom is discussed. For example, in hydrogen atom, the mass of nucleus is 1,838 times of that of electron and this ratio is almost identical to other atoms. Movement of electron groups rotating around the nucleus is similar to that of the solar system in which a planet, such as Jupiter, rotates around the sun. The figure below shows the solar system.



In this figure, circles show the traveling orbits of heavenly bodies. Mercury rotates on the nearest orbit from the sun and then Venus, the Earth and Pluto rotate on each orbit successively away from the sun.

In comparing this figure of the solar system with the already described figure of nucleus, we can discover many similarities. In the solar system the planets rotate around the sun regularly in accordance with the law of universal gravitation between the sun and the stars (all heavenly bodies have a force which either attract or repel one another). Also, with atoms, the electron groups rotate orderly around the nucleus through electrical attraction between the positively charged nucleus and the negatively charged electron (as in the basic rule of electricity, attraction is created between two poles, positively and negatively charged).

Comparing the Solar System and the atom, the mass of nucleus is positively larger than that of the electron, as is the mass of the sun which is far larger than that of other planets. Accordingly the mass of sun is 700 times larger than the combined planets. Speaking of atom size, we find that the distance between electron and nucleus is about 1/100,000,000 of a centimeter, which is the radius of the atom. Such a distance is so little that it is impossible to distinguish with the naked eye. If a grain of millet is magnified to earth size, the size of the atom similarly magnified will appear to be a size of a tennis ball. As mentioned above, the distance between nucleus and electron, or the radius of atom, is extremely short; this distance, however, it is 100,000 times longer than the diameter of the nucleus.

The distance between the earth and the sun is no more than 107 times the length of the diameter of the sun. Therefore, if it were possible to closely observe the sun from the earth, we would find electrons from the nucleus at the end of the sphere.

Such conceptions, as set forth above, were held by scientists on the atomic structure until 1911. However, active studies of the atom since then succeeded in a series of new discoveries concerning atomic structure.

First, scientists learned that the nucleus, considered as merely a single unit, actually consisted of two parts, the proton and the neutron. The proton is charged positively while the neutron is not charged. Later the small unit, "Meson," traveling between proton and neutron, was discovered. Proton and neutron, consisting of nucleus, are equal both in mass and in number in all atoms. Proton, neutron and meson provide the source of energy which is to be utilized for our atomic energy purposes.

The meson is one-tenth the size of the nucleus and sometimes called "Mesotron." Further, a unit named "Neutrino" was discovered and is called "Positron."1/ It is similar to the electron in every respect, except that it is positively charged.

At last, in 1947, HANOBU*, a famous Russian physicist, discovered a new unit, which was later named "Baritron," while studying the cosmic ray. (Cosmic ray is a flow of speeding particles which reach the earth after traveling through space.)

Baritron is, at times, larger or smaller than Meson. By discovering baritron*, difficult questions on cosmic ray

1/ Probably an error in translation -- Ed.

were solved and the study of atomic science will be furthered by this new step. The atom, with a diameter of only 1/100,000,000 centimeter, consists of several electrons, neutron, mestron, and baritron* as component units of the nucleus. Their movements are extremely complex and have abundant energy.

2. What is Atomic Energy?

Atomic energy is energy which exists in the atom. What we wish to know is the location of the energy and how to utilize such natural energy. Atomic energy is the sum total of nucleus and electron group energies. The energy of the electron group is no more than 1/1,800 to 1/4,800 of nucleus energy. Since the energy of an electron group is negligible compared to the nucleus energy, the atomic energy can be taken to mean the nucleus energy. Consequently, atomic scientists are generally concerned only about the nucleus energy. Therefore, only the nucleus energy will be discussed here and the energy of the electron group will not be considered.

As mentioned above, the nucleus consists of the same number of protons and neutrons which are firmly united by strong attraction. This strong attraction between proton and neutron is called the nuclear force in physics, and it is also referred to as the combining energy, since it acts as a combining force. The so-called atomic energy refers to the nuclear force, or combining energy, which means that the large amount of atomic energy is a strong nuclear force.

It then becomes a problem to learn how to best utilize this energy which exists in the nucleus. Fuel, such as firewood, coal, or petroleum, currently being used, contains a large amount of energy and such stored energy will remain in unutilizable condition if it is left alone in its original form. Therefore, we can only use the stored energy by burning the fuel. The technical term 'oxidation' refers to such a process. Burning fuel emits heat, moves trains and warms our homes. If we can emit the internal energy of atom as simply as this, its energy can also be used. The problem of how the internal energy of atom can be released becomes evident here.

Coal or oil can be burned by lighting it, but the use of atomic energy is not so simple. Many scientists have carried out numerous studies in order to solve this question, but as yet no final conclusions have been reached. Great difficulty lies ahead for the natural scientist before the atomic energy problems are completely solved.

The phenomena or the emission of atomic energy was originally raised by chance, with the discovery of radium by the scientists, Mr and Mrs CURIE, 50 years ago when they discovered three radioactive rays of radium. Three rays were named alfa, beta and gamma rays. The alfa ray, a large particle positively charged, flows with the greatest velocity. The beta ray is the flow of high speed electron, and the gamma ray is a radioactive ray similar to X-ray. All rays emit a large amount of energy and none of the energy emitted by rays comes from an outside source, but from the inside of the nuclear force.

Elements such as radium which emit their internal energy without external action are called "radioactive elements." Since the discovery of radium, other radioactive elements, such as the famous uranium, plutonium and thorium, have been found, among which the uranium is the most vital and valuable. Through CURIE's discovery of radium, we know that the atom stores large amount of energy.

According to the present-day knowledge of radium, if one gram of radium releases all its stored energy, it will be equal to 29 hundred million calories of heat, a tremendous amount of calories. This is equal to the heat amount generated by 300,000 tons of coal. The energy released by one gram of uranium is equal to that of 2,100,000 grams of coal.

As mentioned above, there are radioactive elements emitting their internal energy by their own force. However, such radioactive elements require a long period in order to emit all their stored energy. As a matter of fact one gram of radioactive element requires several million years to radiate all of its internal energy in a natural state. Thus, we could not expect energy to play a big part only through natural emission. The important thing, then, is to discover excellent means by which we may cause a simultaneous and large emission of internal energy.

3. Fission of Atomic Nucleus.

Artificial process must be applied from the outside in order to generate enormous atomic energy in a short period.

This research was started when the method of splitting atomic nucleus was discovered. We have learned from the structure of the atom that the neutron is a neutral particle in the nucleus and has a penetrating property which splits other atoms. When this neutron collides with the other atom, the collided atomic nucleus splits into two particles and at the same time two or three neutrons of the atom are released from the orbit. These particles are charged with the same amount of electricity. By electrical repulsion particles escape the nucleus with great velocity and with a large amount of energy stored in the nucleus. In other words, the static energy of the nucleus is converted into kinetic energy. This phenomenon is called "fission of nucleus."

PURENKEL*, the famous scientist of SOVIET RUSSIA, started the first research on splitting of nucleus of the atom. PURENKEL* found that the nucleus of the uranium could be naturally split by a neutron. If one kilogram of uranium was split, the kinetic energy released would be equal to 1,670 billion calories. This energy will be distributed by the particles. The energy of 1,670 billion calories is equal to the amount of calories generated by the burning of 2,100 tons of coal. It would require 70 railroad freight cars of 30 ton capacity to transport this amount of coal. It is not difficult to imagine the extent of damage which will result through instantaneous burning of such a large quantity of coal.

One kilogram of uranium contains a tremendous number of atoms numbering about 1,500,000,[1/] therefore, many neutrons are also required in order to split many nucleus. However, it is extremely difficult to obtain artifically a vast number of neutrons. Therefore, the initial difficulty is the problem of splitting the nucleus of the atom. Later progress was realized on the problem of splitting the uranium atom under the new theory of "chain reaction" of the uranium which was disclosed by PURENKEL*, a member of the USSR Academy. His theory cleared the way for further development on the theory of atomic fission. It is difficult to explain his theory in a few words.

Basically, his theory is: First, several neutrons, which are split by colliding with each other, split other nucleus producing more neutrons, and this process is repeated until the reaction is completed. This continuous fission is called chain reaction. This reaction is a natural phenomenon.

However, such chain reaction occurs only when there is a certain condition within the uranium atom. What condition does it require? The uranium is not composed of a single atom but it is composed of two isotopes, the uranium -235 and the uranium -238. (Two elements having the same atomic number but of different atomic weights are called isotopes.) One isotope accelerates the chain reaction while the other obstructs. The atom of uranium -238 does not split by the action of neutrons, but cuts the speed of colliding neutrons. Thus, finally, the slowed neutrons are absorbed by the

1/ Origin of this large error unknown -- Ed.

uranium 238. The uranium 238 after absorbing the neutrons becomes the uranium 238 which is no longer radioactive and chain reaction ends.

The uranium is not only split by collision with high speed neutrons, but also by collision with low speed neutrons and it accelerates the chain reaction.

Thus, uranium 235, one of the components of uranium, accelerates the chain reaction while the other component, uranium -238 obstructs the chain reaction.

Consequently, if there is sufficient uranium 235 in a uranium, the neutrons acquired in the initial split collides with the surrounding 235 nucleus, successively splitting the neutrons from the nucleus creating a chain reaction. This chain reaction occurs in an extremely short period, similar to any powder explosion. This means that a great explosion will result. The minimum quantity of uranium 235 in a uranium required to maintain a chain reaction is called critical quantity, and this is the state in which the chain reaction can be continued.

Americans have kept secret the critical quantity in order to monopolize atomic energy with the desire of aggression. But this secret has already been exposed by the USSR Academy of Science. A group of scientists in the USSR in cooperation with ARIHANOFU*, discoverer of the baritron, not only have revealed the secret, but also have solved many complicated problems with great success relative to utilization of atomic energy in peaceful industries. Today, the secret of the atom bomb is an old story.

As above-mentioned, the critical quantity of uranium -235 must be contained in a uranium so as to cause the chain reaction within the nucleus. But ordinary uranium ore in the earth crust contains only 0.7 percent of uranium -235. This quantity is not sufficient to meet the critical quantity. (Note: Uranium ore is found in the area of SAKJU and KUSUNG, KOREA.) Therefore, the first problem is to analyze the uranium -235 content of the ore. However, this being a difficult problem, the atom science is stymied.

The excellent scientific and technical groups of the USSR have not only succeeded in solving such difficulties through series of experiments, but also have established a greater plan of industrialization. The total area of the plant is approximately 80,000 PYUNG (TN One PYUNG = 35.583 ft), the length of the building is 800 meters and the width 400 meters. More than 20,000 laborers are required to carry out this project.

The vastness of the project can be judged from the above figures. Thus, in order to analyze the uranium ore, an enormous amount of capital and material is required. Therefore, the scientists have started research on the possibility of utilizing other elements for chain reaction in the nucleus at lower cost. It is said that in the USSR they have already succeeded in their experiment for a new element and an industrialization plan for its production has been set.

4. Utilization of Atomic Energy

It was expected that when this new great source of energy was discovered, great happiness would be brought to mankind. Atomic energy could be of great aid to peace if used for production purposes and for the exploitation of nature by mankind. Through the new source of energy industry could be highly developed. Accordingly, there would be no necessity to build factories near hydroelectric plants or coal mines. With this inexpensive and large supply of energy man could control the climate, and change the climate of the polar regions with heat. Thereby, many new year-round ice-free ports would be created. Also, vegetation of southern regions could be cultivated in the frigid zone. Through the use of atomic energy, various hitherto unseen forms of transportation could be used. It is reasonable to think of traveling to the stars by special planes utilizing this new energy.

Most of these phenomena, of course, are the products of imagination. However, who can say that they will not be realized in the near future? When electricity was first discovered, people could not visualize today's electrical industry, communication and transportation, but it has come about, hasn't it? Our expectations for the utilization of atomic energy will be realized and humanity will profit greatly therefrom.

It must be used for the happiness of mankind, however, in the hands of the US war-mongers, it is used, on the contrary, as a tool of aggression and intimidation, i.e., it is used as a weapon for the murder of masses of people.

The phenomena of fission of the atomic nucleus, which set the stage for the unlimited happiness of mankind, gave rise to US Imperialists' evil plot to attempt to use this weapon for invasion. At the end of World War II, US imperialists dropped two atomic bombs on JAPAN. As the world well knows, the purpose of using the atomic bomb was to gain more advantageous terms in the international circle after the war by turning world attention to HIROSHIMA from

MANCHURIA. In fact, they could not strike a blow at the military power of JAPAN, but they killed a large number of noncombatant citizens. Consequently, there is no need to discuss the atomic bomb because the decisive element contributing to the Japanese surrender was not the atomic bomb but the great military power of USSR.

After the war ended, American imperialists, in cowardice, turned against the strong wishes of the peace-loving people of the world to use atomic energy for peaceful purposes, and the so-called "atomic blackmail tactics" have become all too clear and are being skillfully utilized for propaganda for a new war. What's more, the US imperialists are concentrating on the production of more atomic bombs.

The US capitalists, in thinking that they could accomplish the aims of their present dreams, have forgotten that HITLER's Fascists were also destined to fall by their own dreams. They are attempting to reverse the wheel of progress and are demanding that the development of atomic energy for peaceful purposes, and development of science and technics be prohibited. To hide their devouring ambition American imperialists are falsely propagandizing that atomic energy cannot be used for peaceful means because they will profit more by using it for war, and that atomic energy has enormous explosive power which cannot be controlled by man and that this control, if possible, will not come for several decades.

They tell the American laborers that atomic energy, even if used for peaceful purposes, only saves 20 percent of power, thereby improving the workers' lot by a mere five percent. They ask the workers, "Do you want to work in work so dangerous that it will kill you and your family instantaneously to improve your living condition only five percent?" This is the ignoble deception of the people. Such false propaganda does not come from any scientific basis and is diametrically opposed to scientific principles.

What are the basic reasons for the US imperialists spreading such false propaganda against the possibility of atomic energy being used in peaceful industry? If atomic energy is utilized for peaceful industry, great industrial changes will take place. Accordingly the machines which are the means of production will become obsolete and petroleum and coal will lose their value. What does this mean? It means that the means of production of the capitalists will become worthless. Should atomic energy be used instead of petroleum or coal, petroleum and coal trusts in the UNITED STATES will become insolvent.

Therefore, the monopolistic capitalists will try to turn the interest of the people and the scientists from the problems of peaceful utilization of atomic energy, and force mobilization for the production of the atomic bomb.

On the other hand, in RUSSIA, the possibility that science will turn to weapons exploitation has disappeared. In RUSSIA, all products of science are playing a role in material and cultural improvements for the people. The secret of the atomic bomb was known long ago and has destroyed for all time the desire of the war-mongers in the UNITED STATES, who made it a thing of terror to the world, and were trying to hold the atomic bomb as their permanent monopoly.

While atomic science in the UNITED STATES is suffering under the restraint of the monopolistic capitalists, in RUSSIA the theoretical study of atomic science and the study of how to utilize atomic energy for the establishment of peaceful industry has been progressing systematically.

Scientists in RUSSIA obtained great results from this research. As a result, in the RUSSIA of today, atomic energy is actually being widely utilized for the establishment of peaceful industry.

VISHINSKY, A Y, at the 4th Session of the Political Committee of the UN General Assembly, in an address concerning prohibition of atomic weapons and international control stated: "Atomic energy is not used for the accumulation of atom bombs in SOVIET RUSSIA, but to our regret, if necessary we must have atom bombs. We utilize atomic energy for our economic gains according to the economic plans. Through the aid of atomic energy we are planning great peaceful construction works, such as irrigation of undeveloped lands, destruction of mountains, changing of river courses, and a very new way of life. As a matter of fact, we, as owners of our land, and in accordance with our plans, are carrying these things out. In carrying out these plans we have no obligations to report to or to obey any international organization."

At present, in the SOVIET UNION, great explosions are taking place. These explosions use the latest technical means for the construction of large hydroelectric plants, mines, canals, roads and irrigation works. In these explosions, the ordinary powder is not used, but atomic energy is used. Lately, in the SOVIET UNION, they are planning to improve nature by attempting to make water from the OB and YENISEI Rivers in SIBERIA, which are the largest rivers flowing into the ARCTIC Ocean, flow south into the ARAL and

CASPIAN seas, thereby making the vast undeveloped lands of Central ASIA into fertile cotton fields and vineyard. If this plan is realized the world's greatest artificial lake will appear and through its water resources, we can construct a huge hydropower plant which could produce electricity of 8.2 billion kilowatts.

Engineers and scholars of the SOVIET UNION are now making progress in the great construction, which has never been equaled in human history, by utilizing the great products of science, including atomic energy. Moreover, the engineers and scholars of the SOVIET UNION have built a high speed jet plane which is designed to use atomic energy. Therefore, presently, new jet planes are flying with super high speed in the skies of the SOVIET UNION. The scholars of the SOVIET UNION are delving deeper into such research on an ever increasing scale. The glorious and various possibilities of atomic energy for peaceful purposes will be realized by scholars of the SOVIET UNION, and this will be of great aid to mankind.

5. Leading Contribution of USSR to Natural Science and Atomic Energy Research

Soviet scholars' contributions to the fields of natural science and atomic physics have aided materially to solve urgent problems. For example, the basic theory of modern atomic nucleus structure was discovered by two Soviet professors, IWANENKO*, D D and SAPONDU*, E N between 1931 and 1933. There was an inadequate theory that the atomic nucleus was formed by positive charged proton and negative charged electron. However, the neutron had not yet been discovered. Between 1931 and 1933 Soviet scholars, IWANENKO*, D D and HAPONDU*, E N, announced to the world for the first time that atomic nucleus consisted of neutron and proton. This new theory was recognized widely and decisively by world science and it helped greatly in the progress of atomic science. After this theory was announced, a question in physics as to what atomic energy controls and proton and neutron (combined energy or nucleus energy) was raised.

To be sure, the problems of nucleus energy are basic in the study of physics. The study of nucleus energy was started by Soviet scientists. As a result of research by TAM*, I E, a member of USSR Science Academy, professor IWANENKO*, D D and professor SOKOLROBU*, A A, a firm foundation for the study of atomic energy was established through a new theory that a third particle, meson, exists between the proton and neutron, where a powerful nucleus energy is present. One of our famous scholars, PULRENKEL*, Y I, a member of the USSR Science Academy has been studying this theory continuously. As a result of his research, he has formulated an important theory that the atomic nucleus of URANIUM can be split by neutron. Thus, he opened the door for atomic scientists to solve the problems of atomic energy.

A group of American scientists tried in vain to explain the fission of nucleus for this phenomenon could only be solved by Soviet scholars. As proven by the fact that Soviet physicist, PULROLU*, K N and RETRUJAKOV*, K A, succeeded in demonstrating that the nucleus of URANIUM can be split into two equal parts, which move about in all directions with combined energy or nucleus energy as previously described in the section explaining atomic energy.

During the period 1942-1947, a young group of Soviet scientists headed by ALRIHANOFU*, a scholar of the USSR Science Academy, and his brother ALRIHANYAN*, discovered a particle heavier than proton located between proton and electron. The discovery was made during research in cosmic ray in a superb laboratory located on Mt. ABAKETS, on the Republic of ARMENIA (Elevation 3,250 meters). This new particle was named baritron by Soviet scientists. The discovery of baritron was epoch-making in the field of world science, solving many difficult problems of cosmic ray. With this discovery atomic physics entered into a new advanced phase.

The next matter to be discussed is the discovery of famous Soviet physicist CHERENKOBU*, on the "CHERENKOBU Effect." By the discovery of "CHERENKOBU Effect" it was confirmed that there are particles moving faster than light, which will positively aid in the solving of atomic problems. Soviet scientists in their research on atomic energy were not only successful in theory but also were able to utilize it for practical purposes in production and construction. Presently, RUSSIA has passed through the Atomic Age and is in a new phase of progress and development. There are many ignorant people who believe that the atom bomb is the last product of atomic science. Actually, as we all know, the realization of the atom bomb does not mean the end of atomic science, since the atom bomb was made possible through the discovery of fission of URANIUM nucleus, a first phase of atomic science. Now, in the development of atomic science in the USSR, the atomic bomb age has passed and the new phase of atomic science, the baritron phase, has begun.

Contrary to this, in the US all scientific research laboratories and scientists and technicians working there are strictly controlled by the monopolistic capitalists and absorbed in the production of what they call the "absolute weapon." The development of their atomic science, as in all of their other sciences, is bound by restrictions.

There are several reasons why their level of nuclear physics is still extremely low.

First, the American monopolistic capitalists fear that their present means of production will become completely obsolete in the event some new scientific development in atomic research causes a great change in their industry, transportation, and machinery. Therefore, US capitalists are obstructing all scientific research which contributes to peaceful aims. An American newspaperman, POTA*, said that in AMERICA the science of physics, which is responsible for atomic energy was restricted by its own power of discovery and that it could not progress any further. Even if a scientist makes a new discovery, in AMERICA he cannot put it to industrial use as he desires. The government grants a patent for discovery, but this patent does not in reality, belong to the discoverer. It is bought by the dollars of the monopolistic capitalists. Though the "trusts" which monopolize the patent are able to contribute towards the greater happiness of mankind by peaceful use of the discovery, they purposely bankrupt themselves and use the discovery for other purpose, in the event their interests become affected by such use. For these reasons, in the UNITED STATES, atomic energy is not utilized for peaceful purposes, but instead it is used for imperialistic war which promotes the interest of the monopolistic capitalists.

Secondly, when all scientific research organizations and scientists are controlled by each private company or firm as its own assets, the state has no control over the scientific progress, new scientific ideas, and discoveries. Consequently, there is no possibility of organizing cooperative scientific research work within the country. Therefore, in the UNITED STATES, the scientific progress is prescribed by a few scientists in each individual firm. Under such a situation, a problem as complicated as that of atomic energy cannot be solved. AMERICA has long been endeavoring in vain to achieve what Soviet scientists had already achieved in 1947, when they made the great discovery of BARITRON. She has been unable to solve the problem of cosmic ray, and she will not be able to completely solve the atomic problem.

This is the most difficult problem science has ever encountered. This is not the type of problem that can be solved by scientific power controlled by monopolistic capitalists. This is a problem that can be solved only by Soviet Science which is entirely for the happiness of the people, whose scientific personnel establishments,

...llations, and products can all be uniformly planned, ...whose scientists and technicians can conduct a coordinated ...arch in each of their special fields for the benefit of ...people. The discovery of BARITRON and the "CHERENKOBU ...t" is actual proof of the superiority of Soviet Science.

The fact that such new important discoveries are now ... made continuously in SOVIET RUSSIA definitely proves ... SOVIET RUSSIA plays the leading role in the field of ...ic research. The present Soviet atomic science which is ...t its new phase of development will continue to grow ... the SOVIET UNION and its future is infinitely bright. ...fore, the brilliant leadership in atomic science rests ... the Soviet people, both now and in the future, and no ...alistic nation's science can overtake them. Not only ... field of (the Soviet people's) atomic research but ... in all other fields of natural science, the people are ... of their leadership and are mobilizing the Soviet ...tists for the heroic task of strengthening the power ... Fatherland of Soviet Socialism and for the greater ... of Soviet Science.

The Soviet type "guarantee of priority" in connection ... scientific discoveries is the most important step ... by the Great STALIN and by the Bolshevik Party for ...Soviet scientists.

The unceasing efforts of the Soviet scientists who ...ss noble ideals and abundant energy will secure complete ...tion of STALIN's orders concerning the new progress ...viet science and techniques. Today, all freedom-loving ...es of the world are "blessingly" anticipating their ...ss. This is because the research work conducted by ...t scientists will contribute to the peace of the world.